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# POWER

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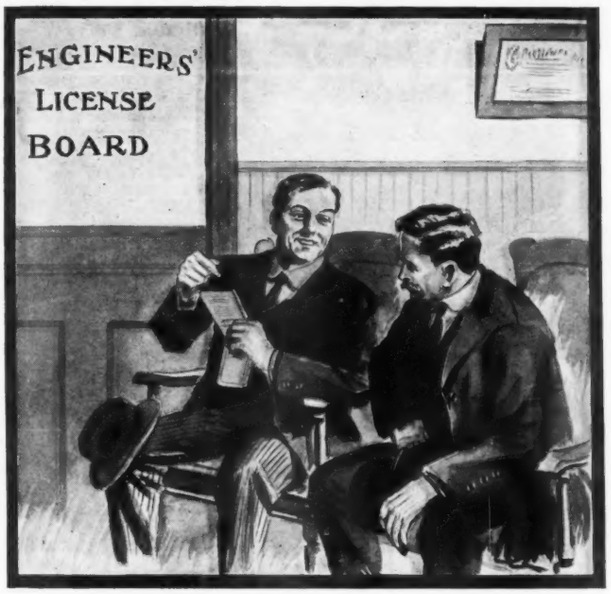


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The following is from the report of tests made under the direction of the Dean of the Engineering Department of a great American University:

"Indicator-cards were taken from each end of the cylinder, the engine making about eighty revolutions a minute. The average totals per card for the *fibrous* sectional ring packing were 71.27 *horse-power*. The engine being then packed with DANIEL'S P. P. P. Packing, and run under the same conditions, the average of total number of cards was 63.85 *horse-power*. Thus the engine while using *sectional packing* required 7.42 *more* horse-power to drive, at the same speed, than while using DANIEL'S P. P. P. ROD PACKING, *which was equivalent to an INCREASED friction on the rod of* 11.62 *per cent.* 7.42 horse-power saved (by P. P. P.) at $80.00 per horse-power, per year, represented a saving of $590.00 per year in coal."—"Story of Some Friction Tests."

## QUAKER CITY RUBBER COMPANY

MANUFACTURER OF MECHANICAL RUBBER GOODS

PHILADELPHIA CHICAGO PITTSBURG NEW YORK

# What Causes Leaky Tubes?

The overheating due to scale.

And you can't end the trouble until you get rid of scale.

There's mighty little use of rerolling your tubes unless you remove the scale.

For they won't stay tight and the beading will get so thin that you'll have to remove the tubes.

Thorough cleaning is the only insurance against leaky tubes.

Now, sometimes, scale forms a patch over the leaks and holds the pressure and the leaks are not disclosed till the scale is removed—makes no difference how it is done or who does it. So, don't blame the tube cleaner for the trouble, if you happen to find a few leaky tubes after you have cleaned your boiler. Just remember that there's a big difference between revealing a condition and creating one.

Yet, there isn't a compound manufacturer that won't try to keep you away from a tube cleaner by telling you it will loosen the tubes.

# The Dean Stops Leaky Tubes

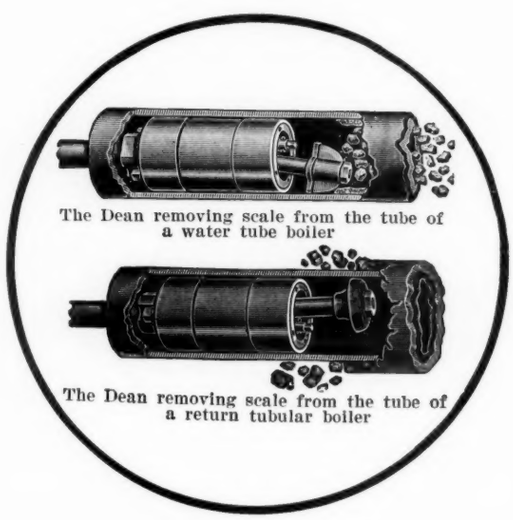
Lots of engineers have been afraid to try the Dean because the compound manufacturers have been so persistent in their **claims** that it would injure their tubes. But what are the facts?

Let a DEAN user tell the story.

Here's what the A. J. West Lumber Co., of Aberdeen, Wash., one of the biggest concerns on the Pacific Coast, say:

*"We had heard a lot of talk about the harm that would be done to the tubes if we used the cleaner and will say regarding this that before we started to use the machine we had had quite a little trouble with leaky tubes, caused, as our chief says, by the formation of scale at the end of the tubes, but since we have cleaned the scale off we have not had a leak. This convinced us and we sent a check for the tool."*

Let us send *you* a Dean on trial.



The Dean removing scale from the tube of a water tube boiler

The Dean removing scale from the tube of a return tubular boiler

## The Wm. B. Pierce Co.

**Jewett Bldg., Buffalo, N. Y.**

**Chicago Office: 801 Steinway Bldg.**

# POWER

NEW YORK, APRIL 18, 1911

"IT ALL depends on how you look at it"—a familiar quotation that. Each of us has used it time and again. It is brimful of truth, too.

Old "Point-of-view" is a wonderful magician. For instance, what an atmosphere of excitement and fascinating romance he throws around the circus performer for the small boy. For days and days after little Willie has been to the circus he practises bareback riding on a kitchen chair and is fired with ambition to become a performer when he grows up. From Willie's point of view circus life is sublime.

But, how differently the man whom Willie so admires looks at the matter! From his point of view life is not all "beer and skittles" by a long shot. He sees the long, uncomfortable and wearying journeys, the one-night stands, the hard work and the monotony of going through the same old "stunts" day after day.

If he could but become imbued with some of Willie's romantic views of his profession, how much more contented he would be, and what a much better performance he would be likely to make. There would be a dash and style to his act that would stamp him as an ARTIST.

In many ways the engineer and his work are similar to the circus performer and his.

To "hoi polloi" the engineer is a wonderful institution and his occupation is full of fascination. He can make all sorts of machines work just when and as he wishes; he understands their intricate construction and when trouble occurs, he knows how to seek it out and eliminate it.

The engineer himself too often considers his work a dull monotonous drudgery. If he could but see and take the interest in it that the layman often does, he would be better off mentally, would do better work and, consequently, would make better, faster progress.

We know of a fellow who once, in fun, called himself an "industrial chemist"—quite a high sounding term. When asked what his line was he said that he manufactured carbonic acid gas. Then, he went on to tell that he was interested in the study of how to utilize a certain byproduct, carbon monoxide.

In plain English, he meant that he was a fireman. The carbonic acid gas which he manufactured was the $CO_2$ in the flue gases; the carbon monoxide, what he called "byproduct," was the CO which was formed through incomplete combustion.

That fellow had the right point of view. He saw the interesting side of his work. He dug into the reasons why certain causes produce certain results, not sometimes but always. He studied. The more he learned the more interested he became. He applied the interesting knowledge that he had acquired "for the fun of it" and he made a wonderful showing.

Today he is superintendent of motive power for a big industrial concern on a salary of $5500 a year.

He still has the right point of view. He gets enjoyment out of his work. No wonder he is making good.

# The Steam Turbine in Germany

By F. E. Junge
and E. Heinrich

*This instalment of the series on A. E. G. turbines deals with features of design, taking up the frame, casing, bearings, lubrication, stuffing boxes, disks and blades, nozzles and regulation.*

All types of A. E. G. turbines have the following features in common:

1. One rigid frame for the whole unit, as shown in Fig. 29.

2. Three bearings, there being only one bearing between steam turbine and electric generator, while a rigid flange coupling is provided on the side of the turbine.

3. A rigid shaft, the critical speed of which is above the normal speed.

*Frame:* Those firms who build both the turbine and the electrical equipment have the advantage that they can cast the two frames in one piece, allowing both parts to be erected and tested together. If turbine and generator are built by different firms, of course, separate frames and separate bearings must be provided and a flexible coupling between the two units arranged. In the latter case the aggregate unit cannot be tested until after erection in the power house, the reliability of operation depending very largely on the ability and thoroughness of the erecting engineers. Here is an element of technical importance which speaks for concentration of production in the shops of one and the same firm. The frame plates of the A. E. G. turbine possess considerable hight and their walls have considerable thickness so that great rigidity of construction is assured. This is important, because light frame plates are apt to bend during erection, changing the relative position of the surfaces which are to fit. The mass or weight of frame is increased by filling its cavities with brickwork or cement, so that no special holding-down bolts are required to fasten the frame to the foundation. If the condensing plant is located below the turbine, as obtains in most cases, the turbine resting on I-beams, a rigid connection by bolts in the manner shown in Fig. 30 commends itself for the sake of stability. From this figure it is seen also that in order to facilitate attendance and avoid stairs, galleries, etc., the frame is set below the engine floor.

*Casing:* The casing of multiple-stage turbines consists of three parts, the front cover and the upper and lower halves of the casing, the latter divided horizontally and containing the low-pressure portion. The front cover and the first wall of the inner partition form a chamber or receptacle in which the Curtis wheel, equipped with two or three rows of blades, revolves. While to this wheel steam is fed to only a portion of the circumference through nozzles, the following wheels, having each only one row of blades, are impinged by means of guide blades with parallel walls, admitting steam over the whole circumference. The guide blades are of polished nickel steel, very accurately cast between an external

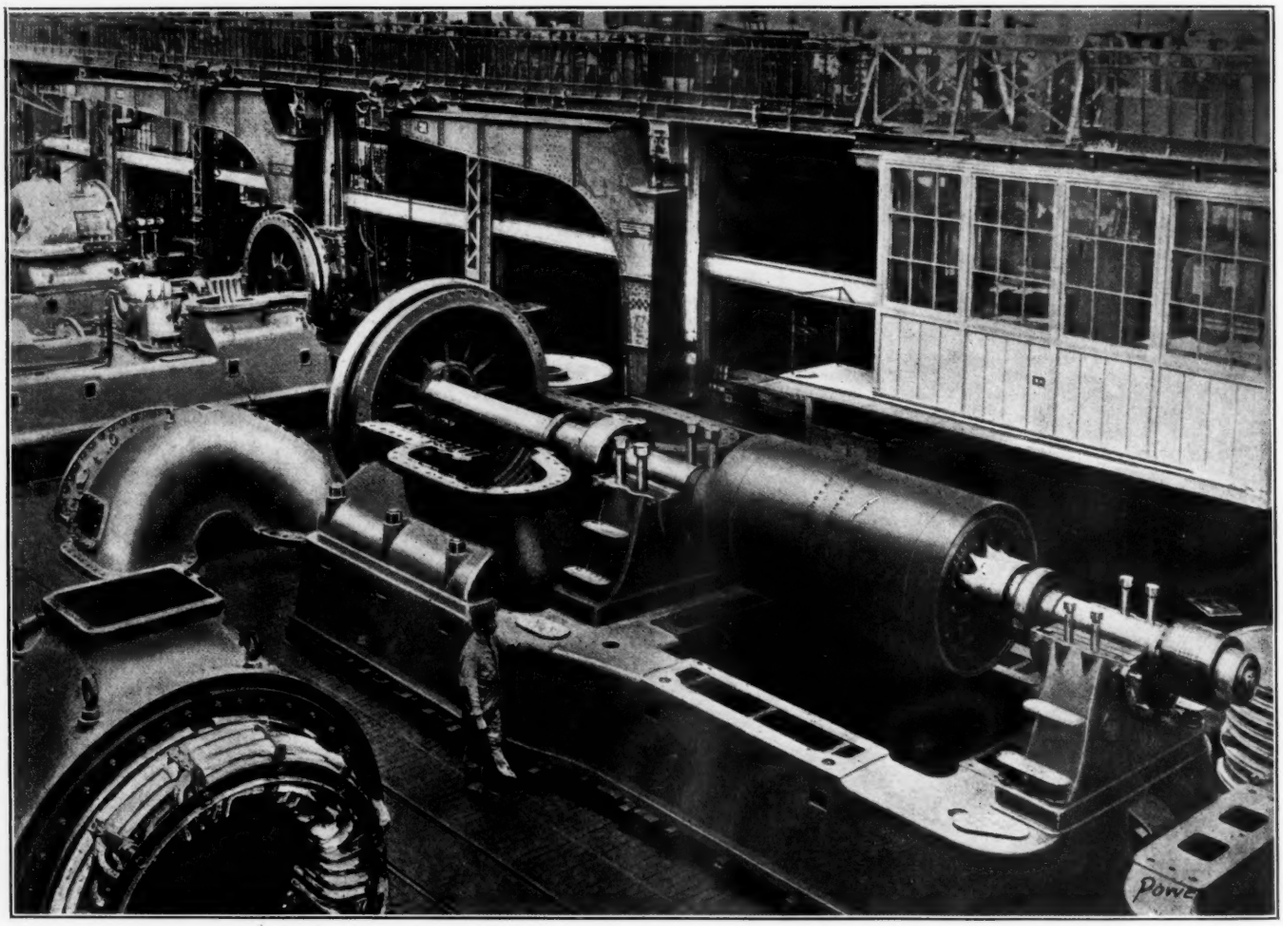


FIG. 29. A. E. G. TURBINE DIRECT CONNECTED TO 6000-KILOWATT THREE-PHASE GENERATOR IN COURSE OF ERECTION

and an internal cast-iron ring. These guiding rings are fastened in the two halves of the casing and remain there if the shaft, the wheels, and the separating walls are dismounted. The separating walls rest on the hubs of two consecutive low-pressure wheels. When the turbine is being mounted the key projecting from the inner circumference of the guiding rings engages the slots cut in the circumference of the separating walls. This construction is lately being replaced by another, which employs disks consisting of two parts, similar to those used in other makes. Disks made of one piece possess several disadvantages. If, for instance, the packing on the hub gets overheated, in order to obtain access to the source of trouble it is necessary to dismount the whole turbine and to withdraw the wheels from the shaft, which is a very difficult or, at least, complicated piece of work. This may occur when the turbine is connected with the exhaust, so that higher temperatures occur suddenly in the casing.

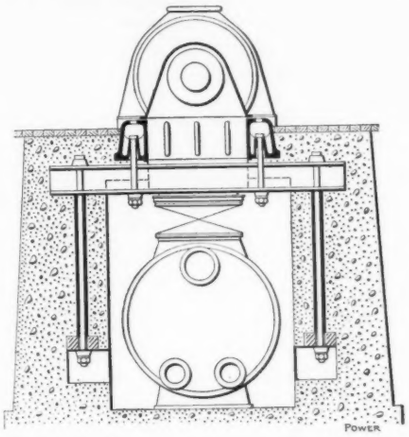


FIG. 30. FOUNDATION AND FRAME

The front cover is, as a rule, a steel casting, while the other sections of the casing are made of cast iron. Fig. 29 shows a turbine of high capacity (6000 kilowatts), of which the lower half of the casing with the guiding rings and the front cover with the nozzle segment are already mounted. The upper half of the casing lies on the floor. The two other turbines in the picture also show the composition of parts very clearly.

The construction of the high-speed type, in which two wheels are used, is somewhat different, no horizontal division throughout the casing being provided. The vertical section, Fig. 27, and the horizontal section, Fig. 28, show the details of construction very clearly, while Fig. 31 shows how this type of turbine is dismounted. First, the front cover is removed, then follows the first running wheel, afterward the intermediary guiding wheel, and finally the second running wheel. In order occasionally to inspect the inner working parts of the turbine, especially the nozzles and blades, it is not necessary to dismount the machine. As for the first stage, inspection can be made by removing one of the nozzle chests, while on the low-pressure part openings with covers are provided, permitting a complete inspection of the second stage.

Though during operation the casing is subjected to low pressures only, all parts before leaving the shop are tested under several atmospheres of water pressure in order to locate porous or weak spots in the castings. In the A. E. G. construction the front bearing with the governor and oil-pump drive is connected by means of bolts to the front cover. Owing to the wide range of expansion in the first stage the temperatures in the casing are comparatively low; hence, this mode of construction is fairly free from objection. Some designers, however, prefer to separate the front bearing entirely from the casing by extending the base plate beyond the front side of the turbine.

*Bearings:* In the design of steam-turbine bearings the following general considerations arise: If $p$ is the pressure per unit of area, $w$ the circumferential velocity of the journal in units per second, $l$ its length, $d$ its diameter and $u$ the coefficient of friction, then we have $R = l\,d\,u\,p\,w$, the friction work of the journal per second and $r = u\,p\,w$, the friction work per unit area of the horizontal projection of the journal, or what is called the specific friction work. The results of all experimenters go to prove that the product $u\,p$ is constant for all pressures within the available limits; hence, we can use as a measure for the friction work per second the readily determinable product of the pressure and the circumferential velocity of the journal. Until lately this value was kept quite

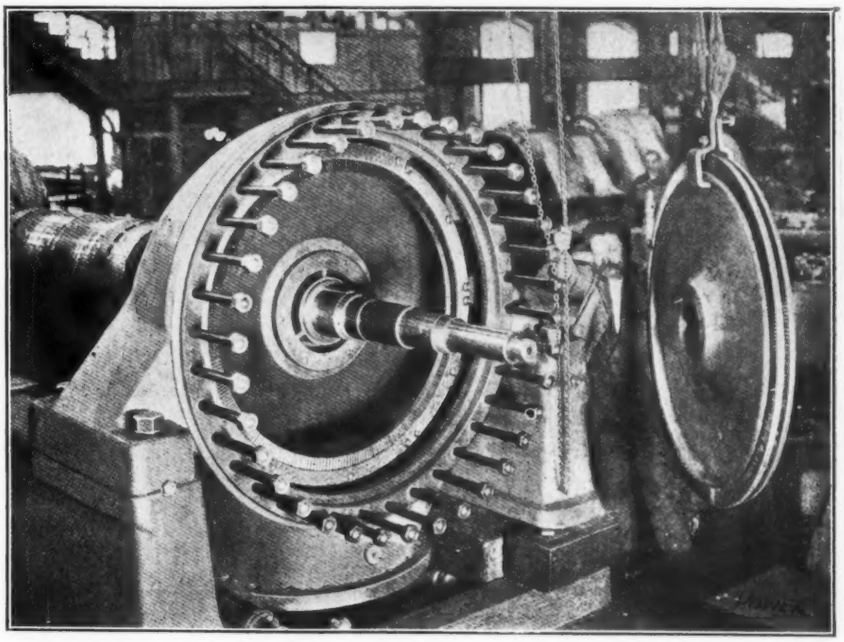


FIG. 31. A VIEW SHOWING INTERIOR CONSTRUCTION OF TURBINE

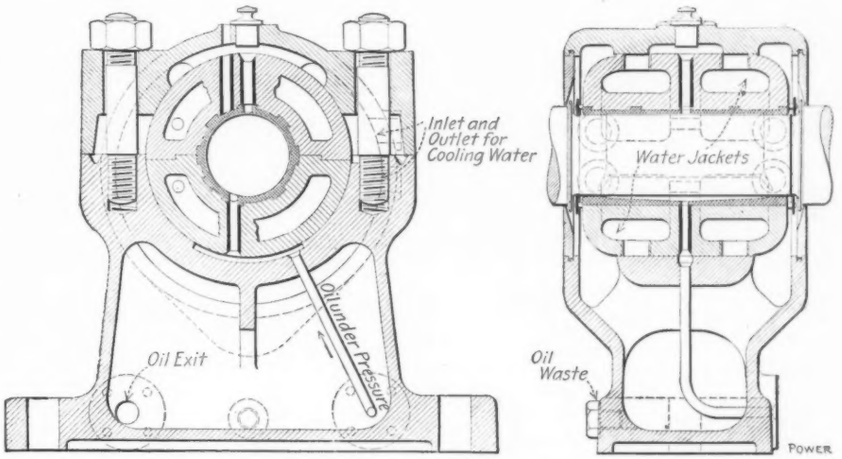



FIG. 32. SECTIONAL VIEWS OF MAIN BEARING

low, especially when employing flexible shafts, the dimensions of bearings being laid out amply large. The value $pv$ seldom surpassed 40 meter-kilograms, or, in English units, 1830 foot-pounds. Today all firms follow the example set by the Allgemeine Elektricitäts Gesellschaft. They shorten their turbine bearings, permitting a value $pv = 130$ to 150 in metric, or 6000 to 7000 in English units.

The construction of bearings embraces two parts: floor stands, or pedestals, and boxes. The former rest upon and are rigidly fastened to the base plate. The bushings are lined with white metal and are fitted by hand into the boxes, thus guaranteeing an oil-tight fit all along the surface; see Fig. 32. Lubrication is effected by means of oil pumps driven from the turbine. The oil piping is connected to the pedestal and extends in its interior up to the bottom end of the bushing. The oil enters through a vertical channel into a broad groove, being driven by the revolving shaft toward the center line of the bearing, where the highest pressure occurs, and emerging on both sides into the cavities of the pedestal. The front bearing is constructed similarly to the rear one, with the difference that it contains the thrust journal. The main purpose of the latter is not to receive and absorb heavy shocks or stresses, but to maintain the relative axial position of rotating and stationary parts and to preserve and control the interstices and play which are provided during erection. As the pivot journal is subjected to wear the collars are not made in one piece with the shaft, but are attached to the latter, together with the worm gear for driving the governor, so that they may be easily exchanged.

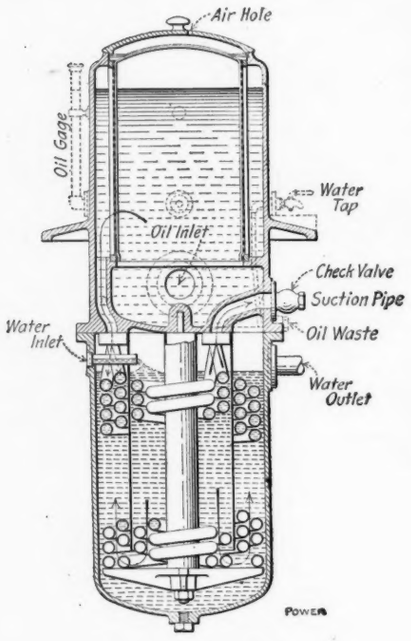



FIG. 33. OIL COOLER

*Lubrication:* The convection of the friction heat is effected partly in the bearing itself and partly by means of special oil coolers, similar to those used in other turbine systems. In one construction the brasses are made hollow so that the cooling water may pass through them, before it enters the oil cooler. In other constructions the lubricating oil, coming from the oil cooler under pressure, is itself used to cool the bushing from without before entering the wearing surface within. The cooling of the oil is effected in a special apparatus, shown in Fig. 33. In the upper part the hot oil, returning from the turbine, is collected, and the impurities contained therein are allowed to settle to the bottom and can be removed from time to time. On its way downward the oil passes through a fine brass sieve which retains the solid particles, such, for instance, as come from the inner surfaces of the pedestals, oil pipes, etc. After being filtered the oil enters a cooling coil, yielding its heat to the cooling water. Thence it is drawn through the oil pump and started again, circulating through the system. It is obvious that the loss of oil in this system is quite small, yet there are losses caused partly by evaporation, partly by the fact that the lubricating value of oil decreases after some time, so that the oil must occasionally be renewed. The oil in the tank serves also as a reserve supply, guaranteeing the circulation in case, owing to some defect, the lubricant should leak out during operation. The oil pump which is driven from the governor consists of two spur pinions meshing in the ordinary manner. The absence of valves, pistons, springs, etc., favors reliability of operation. When starting, the speed of the governor and oil pump is too low to secure the delivery of suffi-

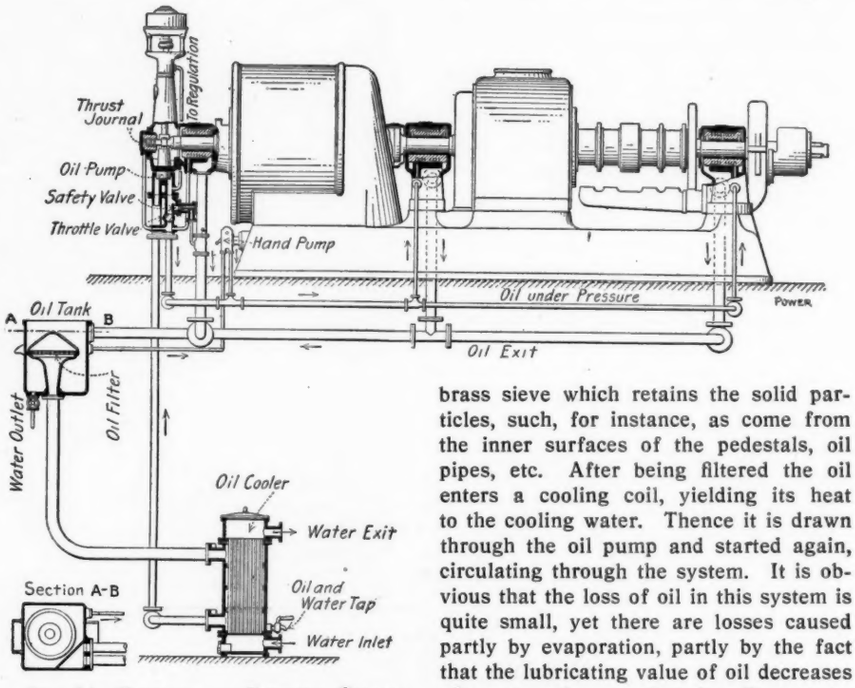



FIG. 34. OUTLINE OF TURBINE OILING SYSTEM

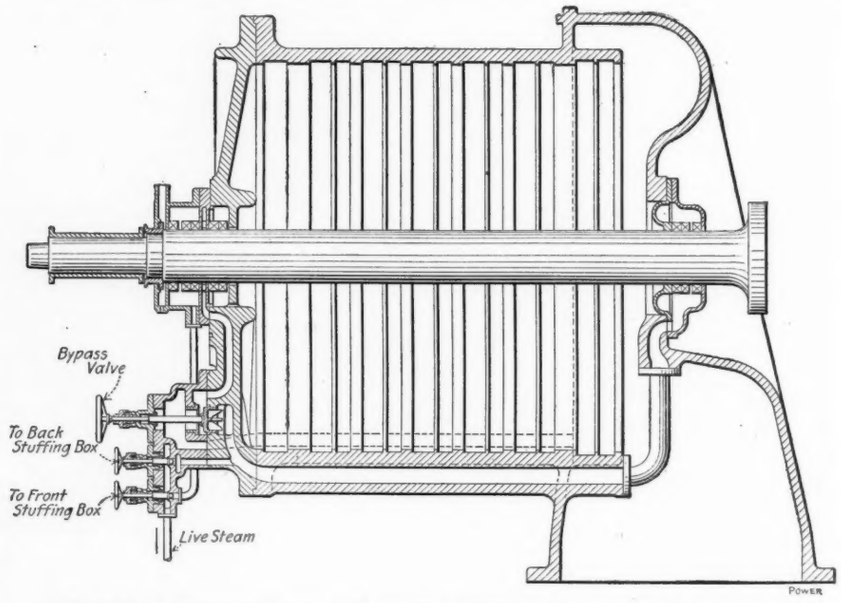



FIG. 35. SECTIONAL VIEW OF TURBINE, SHOWING LABYRINTH PACKING

cient oil under pressure. For this purpose a small emergency hand pump is provided, and for larger units a special steam-driven auxiliary oil pump is provided, which supplies the lubricant until the main turbine is up to speed. Oil circulation and pressure can be controlled through several gages, being switched in at different places by means of valves. The temperature of the oil is registered and observed both in the tank and on the bearings, for which purpose thermometers are inserted in the upper bushings. The whole scheme of oil circulation is illustrated in Fig. 34.

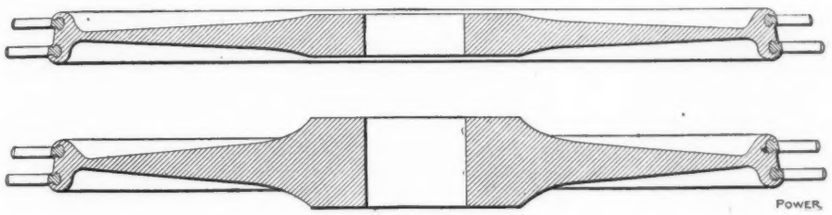



FIG. 36. DISK WHEELS WITH FACTORS OF SAFETY OF 5 AND 10

*Stuffing Boxes:* The packing of the turbine shaft on the high-pressure side is a comparatively simple matter, because in the first chamber the pressure is comparatively low. In the multiple-stage A. E. G. turbines the pressure difference is about three atmospheres. In the two-stage types the pressure is zero at full load and can even become negative at the lower loads. In this case the pressure of the atmosphere without is higher than the internal steam pressure, the effect being the same as on the low-pressure side. With the high circumferential speeds occurring in steam turbines it is, of course, impossible, to employ the same packings which are used in steam-engine practice. Neither soft materials pressing around the shaft nor metal packing rings can be used. As to the latter they could hardly be kept tight without being cooled, and would require lubrication which is apt to spoil the condensate for boiler-feeding purposes. A labyrinth packing is, therefore, employed in which the steam itself acts as a packing medium, being forced to flow through a series of ring grooves and being gradually throttled down, its acquired velocity being absorbed in enlarged spaces located between the grooves. The steam travels through the labyrinth packing from without to within, the low-pressure box being arranged behind the high-pressure stuffing box; see Fig. 35. The latter is surrounded by two annular channels which connect through radial passages with the labyrinth proper, dividing the latter into three parts. The outer channel receives the steam after it has been throttled in a reducing valve to a certain pressure, while the inner channel connects through a pipe with the annular chamber of the low-pressure stuffing box. Through this connection the vacuum in the low-pressure stage of the turbine draws steam through the middle labyrinth of the high-pressure stuffing box, but at the same time it draws steam from the first turbine chamber in and through the low-pressure stuffing box, so that the steam used for packing is included in the condensed water of the turbine. The low-pressure stuffing box also contains a special admission for throttled live steam which is used in case not enough packing steam is supplied through the above-mentioned connection. The short outer labyrinth chamber prevents the leakage of steam so perfectly that only a slight trace of vapor is visible, by which indication the proper adjustment of the admission of packing steam is controlled. On the high-pressure side the steam is emitted through a short vertical pipe in order to prevent the settling of sediment within the box. The collars of the shaft are made of steel, the meshing collars of the surrounding boxes of nickel bronze. Though the play allowed in the labyrinth is quite small it is ample to permit such expansion and contraction as result from the heating and cooling of the shaft.

Another form of packing which commends itself in certain cases employs rings made of carbon, which are pressed together by means of springs, the rest of the arrangement being identical with that above described; but for shafts which rotate at high speeds the labyrinth packing is preferable. Though not giving absolute tightness it has the great advantage that it works without friction and requires no lubrication, the steam friction in the labyrinth being a negligible amount. Thus the labyrinth packing makes possible one great advantage of the steam turbine over the steam engine; namely, the output of a condensate which is free from grease. The inner packings between two consecutive chambers are also of the labyrinth variety but simpler, the shaft having no collars but running through. The amount of play permitted depends entirely on conditions of operating reliability, the leakage of steam being accepted as an unavoidable loss.

*Disks and Blades:* Disks are made of high-class steel, a high factor of safety being assumed for their computation. Fig. 36 gives a comparison of a normal A. E. .G. wheel built for tenfold safety with a wheel computed for half this amount. Wheels carrying two rows of blades have enlarged rims in which the blades are inserted. The heavily built disk hubs are fastened upon the shaft by means of conical caps in order to

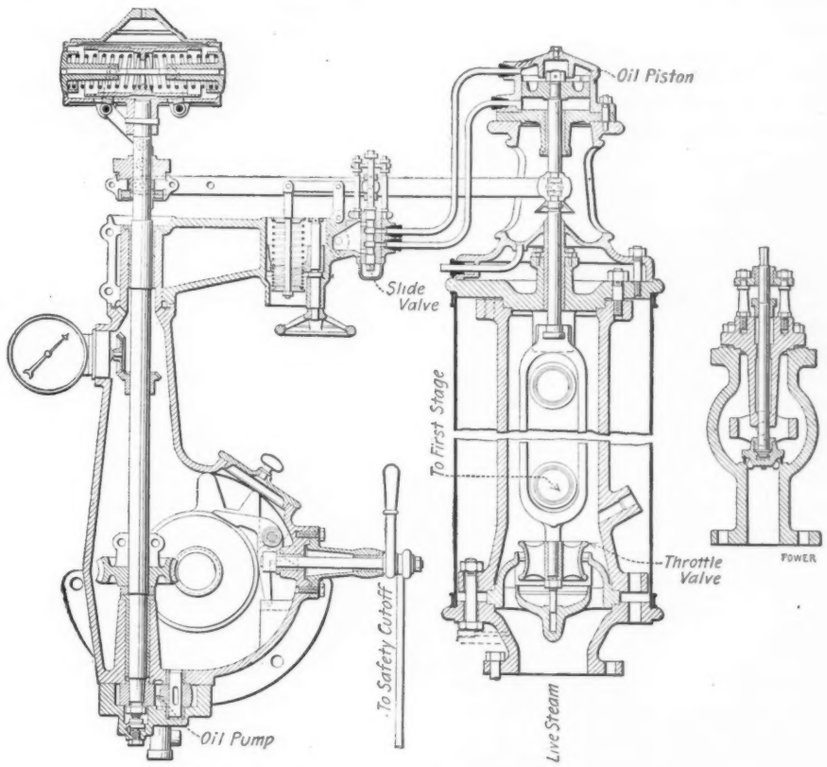



FIG. 37. GOVERNING MECHANISM OF TURBINE

secure accurate fit and ease of dismounting. The blades are made either of a special bronze alloy or of nickel steel. They are cut from solid profile bars, being set into the rim at an enlarged portion of the groove. The space between two consecutive blades is filled in with a special piece which projects as high as the foot of the blade and fits accurately into the profiled part of the blade. It thus insures the accurate spacing of the blades as well as their uniform inclination. After the whole circumference of the disk wheel has been filled with blades the distance pieces are staked so as to give an absolutely firm hold. Then the blade heads are connected by a steel band, which fulfils the double purpose of stiffening the blades radially and creating in the rotating wheel a closed channel for the working steam. The blades of the reversing wheels are built in the same way as the others. After being equipped with blades the wheels are carefully balanced statically, a dynamic adjustment being in most cases unnecessary on account of the symmetric form of the wheels.

*Nozzles:* The impingement of the steam upon the blades is effected either through guiding channels with parallel walls or through conically diverging nozzles. A longitudinal section through the nozzles of a two-stage turbine is shown in Fig. 27, which also shows how the nozzles are superimposed and with their rectangular mouths give a continuous outlet. As material for nozzles, bronze or nickel steel has given satisfaction. For the form of apparatus which is built for high superheat, a special grade of cast iron is employed. If corroded, these parts can be easily replaced without excessive cost. The ease of exchange is a desirable feature, particularly in cases when the operating conditions of the plant change materially, as when turbines are connected to a new boiler plant with different pressure, or when superheaters are installed.

*Regulation:* The requirements of electric drive necessitate the accurate maintenance of the normal speed at all loads as well as a small and short deviation from the normal number of revolutions at sudden variations of load. These requirements are more easily met with steam turbines than with reciprocating engines, because the degree of irregularity—using an expression from steam-engine practice—is almost zero, the mass of revolving parts acting like a flywheel toward the balancing of small irregularities. The governing device of A. E. G. turbines is shown in Fig. 37. The vertical governor is driven through a worm gear from the turbine shaft and moves a small balanced piston valve, which opens the ports to the cylinder, the piston of which controls the main steam valve at the slightest deviation from the center position. When the sleeve of the governor ascends the pilot valve descends, thereby opening one channel for the admission and another for the outlet of oil under pressure. The regulating valve proper, a double-seated balanced poppet

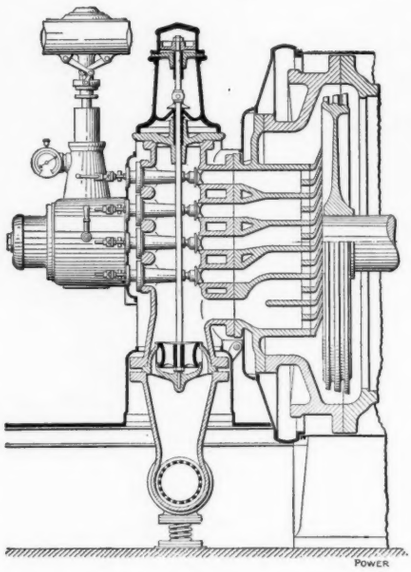



FIG. 38. ARRANGEMENT OF NOZZLES

valve, is rigidly connected to the piston of the controlling cylinder. When the speed of the turbine increases the governor throttles the admission of steam, the downward movement of the piston ceasing when the pilot valve is pushed back into the central position. As the lever has no fixed fulcrum the slide link must be considered as fulcrum. Thus to every definite position of the governor corresponds a certain definite position of the throttle valve. The oil for the pressure cylinder is supplied from the same pump which delivers the lubricant to the bearings under pressure. The advantage of this mode of governing is, of course, that it exercises no harmful back pressure on the governor, the sensitiveness of the latter being therefore quite high. For sudden load variations up to ± 25 per cent. the change in the number of revolutions does not amount to more than ± 1.5 per cent. At sudden drops from full load to no load a momentary increase of 5 per cent. takes place. In the condition of permanence the difference of speed between no load and full load is 4 per cent. Every turbine possesses a device for changing the normal speed by ± 5 per cent. during operation, which is essential for running alternating-current generators in parallel, the device being actuated either by hand at the turbine or from the switchboard.

In the above described system of regulation the governor changes the position of the throttle valve and thereby at the same time the quantity and pressure of the steam supplied from the boiler. This reduction of pressure, however, causes a certain loss of energy, which finds expression in an increased steam consumption per horsepower. The method of partial or graduated admission as employed in A. E. G. turbines makes it possible to transfer regulation of the quantity of steam admitted directly to the nozzles, so that at partial loads the throttle valve may be in a more elevated position whereby losses through reduction of pressure are diminished. The more perfect and differentiated the change of admission the more noticeable is the improvement of throttle governing.

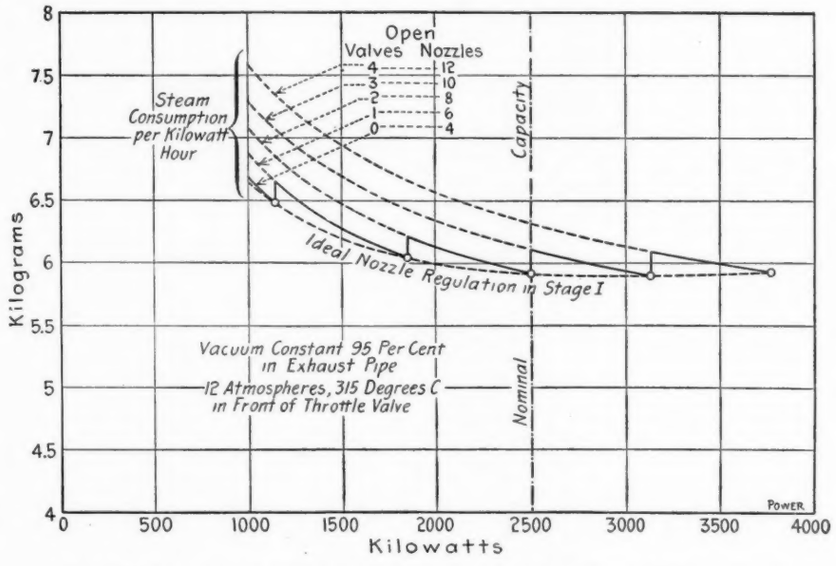



FIG. 39. INFLUENCE OF THROTTLE REGULATION ON STEAM CONSUMPTION

In the A. E. G. system of automatic nozzle regulation the pressure piston actuates a curved gear by means of which the single nozzles or groups of such are opened and closed through a series of valves. In this case of pure quantity regulation the throttle valve is eliminated

entirely. Between complete cutoff and maximum overload the governor attends automatically to the most favorable grade of admission. This mode of regulation is commended wherever rapid load variations in irregular and short intervals are expected to occur, as in iron and steel works, rolling mills, mine hoisting plants, etc. In plants where wide load fluctuations do not occur irregularly, but at certain intervals and gradually, as in central stations and in most factories, it is sufficient to cut off one or more groups of nozzles by hand, according to the momentary requirement, regulation being effected automatically by throttling from the governor. The attendant notes from the gage pressure before and behind the throttle valve when a change of admission is necessary, no order from the switchboard being required. If the pressure difference between the steam coming from the boiler and the steam as recorded behind the throttle valve exceeds a certain measure, it is proof that there is too much loss by throttling and that the time is at hand to cut off one group of nozzles. In turbines of 3000 revolutions per minute, of the total system of nozzles of the first wheel, ordinarily two groups are arranged to be cut off, one of them being reserved for overload, while the other must be closed when the turbine is working on half load. In the larger types the nozzle system is divided into four groups (see Fig. 38), a portion of these always remaining open. Diagram, Fig. 39, shows the favorable effect of this mode of regulation on steam consumption.

The upper limit of load is fixed by the heating of the electrical part, the turbine itself being capable of standing overloads far beyond this limit, and for any length of time. The surplus steam required is admitted by opening additional nozzles. The latter are used also when operating conditions grow less favorable than was assumed for the design, especially when the condensing plant for some reason or other becomes defective and the turbine must exhaust into the atmosphere while the load is being maintained. For two-stage turbines working with atmospheric pressure in the first stage (at full load), there is, of course, no further drop of pressure in the second stage when the condenser is eliminated. The maximum load which under these circumstances can be carried by the first wheel alone reaches 80 to 100 per cent. of the normal full load. In this case the major part of the exhaust steam passes from the first chamber through an auxiliary outlet directly into the atmosphere. For very large units no arrangement of the sort is provided because it is assumed that the considerable quantities of additional steam required for direct exhaust cannot be supplied by the boiler plant, and because in most cases there is always a reserve unit available to take the place of the one whose condensation is defective; but for smaller plants the ability to carry heavy loads with direct exhaust means a great deal, wherefore the provision of additional nozzles is essential.

Besides the above described mechanism for speed regulation and the devices for securing stability of operation under less favorable working conditions, the A. E. G. turbines are equipped with an independent shaft governor, which serves exclusively for the purpose of preventing racing of the turbine, if the other regulating device should fail to work. The governor which was shown in Fig. 27 is so adjusted as to effect the immediate closing of the main admission valve, Fig. 40, if the speed surpasses the normal by 10 or 15 per cent.

In conclusion we give an interesting comparison of tests made on a 4000-kilowatt A. E. G. turbine (Rummelsburg central station), and on an 8000-kilowatt Curtis turbine built by the General Electric Company (Chicago, Fisk Street station), which will serve to illustrate our remarks on thermodynamic efficiency in the last article. From tests 2 and 3 is seen that the 4000-kilowatt A. E. G. turbine, though having to transform a greater heat drop than the 10,000-kilowatt General Electric turbine, shows a superior thermodynamic efficiency than the latter. If the heat drop was equal in both cases, the comparison would come out even more favorable for the German turbine. How great the influence of heat drop actually is can be seen from tests 3 and 4, made on the General Electric turbine. At a drop of 220 units the efficiency is 66.2 per cent.; at a drop of 240 units the efficiency is reduced to 61.2 per cent. Finally, the favorable effect of the nozzle regulation of the A. E. G. turbine is characterized by tests 1 and 2, showing practically equal steam consumption per kilowatt-hour at half and at full load.

A COMPARISON OF THE A. E. G. AND CURTIS TURBINES.

| | A. E. G. Turbine. | | General Electric Turbine. | |
|---|---|---|---|---|
| Trial number | 1 | 2 | 3 | 4 |
| Output, kw | 2,200 | 4,239 | 10,156 | 10,000 |
| Pressure in front of turbine, kg. per square centimeter absolute | 13.4 | 13.2 | 13.4 | 13.7 |
| Temperature, deg. Cent | 334 | 350 | 274 | 262.8 |
| Steam consumption per kw.-hour, $D_{el}$ | 5.4 | 5.43 | 5.85 | 5.919 |
| Theoretical heat drop in metric units, $H_0$ | 253.5 | 249 | 240 | 220 |
| Theoretical steam consumption, kg. per kw.-hour, $D_0'$ | 3.39 | 3.45 | 3.58 | 3.937 |
| Efficiency, $\eta_{el}$ | 62.8 | 63.6 | 61.2 | 66.2 |
| Condenser pressure, kg. per square centimeter absolute | 0.018 | 0.023 | 0.018 | 0.0345 |

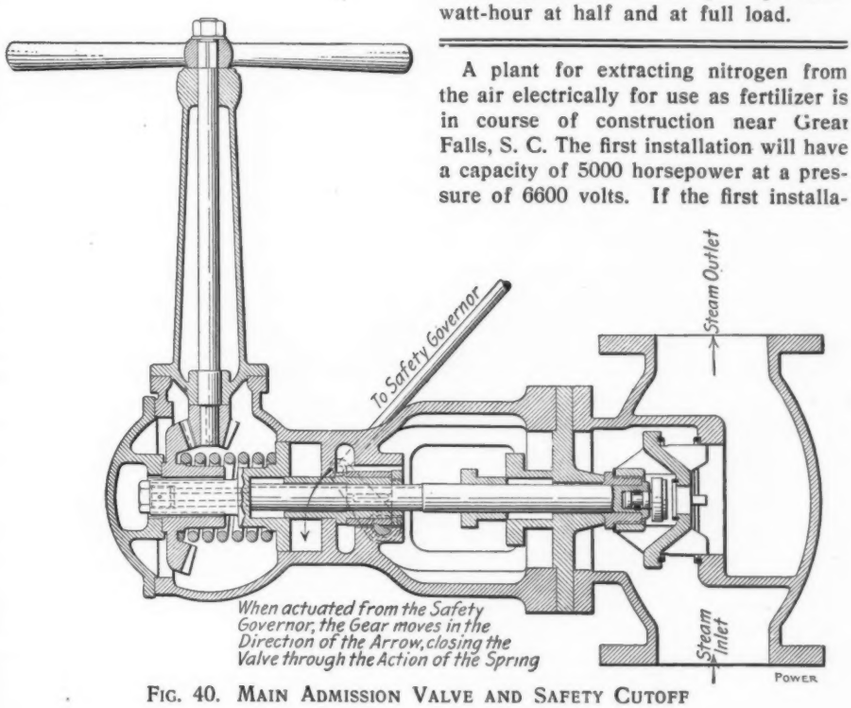

To Safety Governor
Steam Outlet
When actuated from the Safety Governor, the Gear moves in the Direction of the Arrow, closing the Valve through the Action of the Spring
Steam Inlet
POWER

FIG. 40. MAIN ADMISSION VALVE AND SAFETY CUTOFF

A plant for extracting nitrogen from the air electrically for use as fertilizer is in course of construction near Great Falls, S. C. The first installation will have a capacity of 5000 horsepower at a pressure of 6600 volts. If the first installation proves a success additional equipment will be added to the plant later to bring the capacity up to 25,000 horsepower. No details of the process are available at present, but it is reported that the nitrogen is extracted by means of large electric furnaces and absorbed by means of crushed limestone.

# Some Experiments with Gage Cocks

By W. H. Wakeman

*Some of the methods of attaching gage cocks and glasses to steam boilers, with comments upon the advantages and disadvantages of each arrangement.*

The first boiler of which I had charge was of the locomotive type and had three gage cocks tapped directly into the outer head as shown in Fig. 1. There was also a water gage on the same head. This is a very natural arrangement, because each cock is independent of the other; hence if one is disabled it does not interfere with the other two. If the water level, as indicated by the gage glass, agrees with the gage cocks, it is double evidence that the true level of the water in the boiler is known.

Another boiler which I operated was fitted with a water column, as shown by the full lines in Fig. 2. No valves were

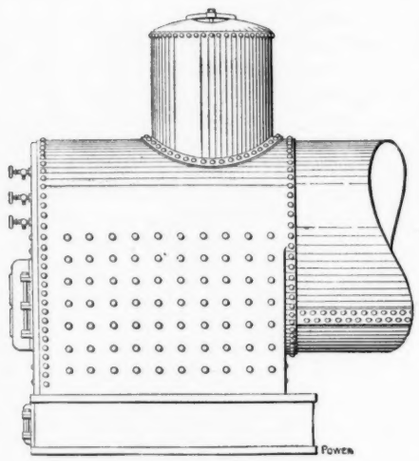


FIG. 1

inserted between the boiler and the gage cocks; hence the water column could not be shut off from the boiler. There was no drip valve connected to it, and this resulted in sediment collecting in the connections and causing trouble.

In another plant the boiler was fitted with a water column as already illustrated in Fig. 2, except that a ⅜-inch drip pipe was provided as shown by the dotted lines. This permitted some of the sediment to be blown out, but the pipe was not large enough to cause a rapid flow of water and steam through the connections, especially as it was not possible to shut off one while creating circulation through the other. When the drip valve was opened the water discharged directly onto the boiler-room floor, and this being far from pleasant, I bored a hole through the side of the building and extended the pipe through the wall. This disposed of the water as far as I was concerned, but there was danger of scalding people who passed the boiler house; hence the pipe was taken out and connected into the ashpit. Having cleaned the boiler front I proceeded to blow down the water column and in a few seconds practically the entire front of the boiler was covered with ashes, although the damper was wide open. Exactly the same result has been secured wherever I have tried a similar experiment; therefore, I consider the arrangement an unmitigated nuisance.

In three other places tubular boilers were fitted with gage cocks connected into the front head but, owing to the combustion chamber or smoke box being located at this point, it was necessary to provide a pipe about 20 inches long for each cock, also for each connection to the gage glass. These are illustrated in Fig. 3 but in the sketch the water gage

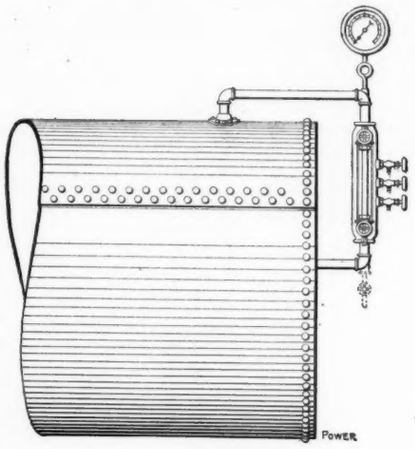


FIG. 2

is extended farther than it actually was in practice, in order to avoid interfering with the cocks. Some of these pipes were exposed to the direct action of the flames and hot gases while others were protected by sleeves consisting of pieces of larger pipes.

All of these connections slowly filled with sediment because the opening provided was not large enough to permit rapid circulation through the connecting pipe when a gage cock was opened. Special attention was given to cleaning these pipes when the boilers were cleaned, and sometimes it was necessary to remove the gage cocks in order to force sediment out with an iron rod. All of it did not bake hard in the pipes but when one of them was filled with a paste-like substance, it effectually prevented proper use of the gage cock. It was my custom to lift the weighted end of a gage cock and run a long wire into the pipe. This opened a passage temporarily, but sometimes it would fill and cease to discharge water before the cock was closed, thus proving very unsatisfactory. Such action always smeared the boiler front with mud.

At another plant the boilers were fitted originally with water columns having connections as shown for the water gage in

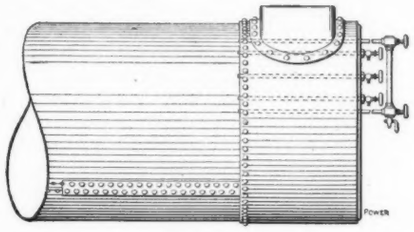


FIG. 3

Fig. 3. Valves were not provided in the connections; hence when anything happened to the water gage, or the three gage cocks attached to the column, it was necessary to remove all pressure from the boiler in order to make repairs. I accordingly altered this arrangement by placing a valve in each connection to the gage; therefore, when a glass broke, steam and water could be shut off while a new one was being put in. In order to prevent trouble from breakage of glasses

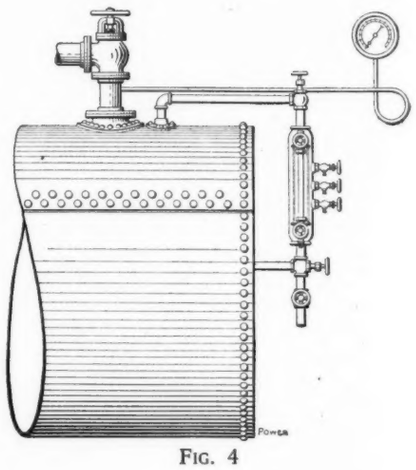


FIG. 4

during the night, the fireman made it a practice to shut these valves before he went home. Of course, this prevented the glass from showing a true water level in the morning, but he was intelligent enough to open them and ascertain how much water was in the boilers before starting the fires, as they were rebuilt every morning. A steam gage was attached to the top of each column, by a very short connection, in which there

was no siphon to hold water. Examination of this piping when the boilers were empty, showed that a straight pipe extended down into the column below the water line, protecting the end of this pipe from steam except when the column was blown down to remove the sediment.

Upon taking charge of the boilers in another plant, I found the water columns attached as shown in Fig. 4, the connections consisting of 1¼-inch brass pipe. The drip pipes in this case were carried to the sewer without reduction in size, which proved very effective. These columns were also fitted with high- and low-water alarms. As a rule, I closed the valves in these connections, and opened the drip valves when leaving for the night; but one night I was awakened by a policeman who informed me that something was out of order in the boiler room, and he suggested that I go down and attend to it without delay. Upon arriving at the boiler room I found one of the alarm whistles blowing, as the valves had not been left according to my usual custom.

How do engineers manage to take care of columns fitted with high- and low-water alarms, that have no valves by which to shut them off at night? Do they make arrangements with the local policeman to attend to this duty in their absence, or is it possible to always have the water level low enough to keep one float down, and high enough to support the other, and thus always prevent the whistle from blowing? Do accidents ever happen to the floats at night? If so, how are they repaired when pressure cannot be removed from the column?

Gage cocks connected into these columns never become choked with sediment, the boiler fronts are not bespattered with mud when they are opened, and the connecting pipes are not in danger of filling with mud, nor of being injured by excessive heat. For these reasons one large connection above and another far below the water line, where neither is liable to be rendered useless except by gross carelessness continued for a long time, seem to be much superior to several small and independent connections located where they collect sediment readily and are liable to be burned by the intense heat.

# Flow of Steam and Design of Nozzles

By A. D. Blake

*Development of formula showing the velocity attained by a jet of steam in expanding from a higher to a lower pressure and its application to the design of a simple nozzle.*

In order to thoroughly understand the action of steam in flowing from a higher to a lower pressure it is first necessary to have a clear conception of the fundamental principles of work and energy. Consider a freely suspended body of mass $M$ being acted upon by a constant horizontal force $F$. If all friction be neglected, the force $F$ will produce an acceleration of the mass $M$ equal to $a$ feet per second per second; that is, starting from rest, the velocity at the end of the first second will be $a$ feet per second, at the end of the next second it will be $2a$ feet per second, at the end of the third second $3a$ feet per second, and so on. Now let the mass be doubled. In this case it will require a force of $2F$ to produce an acceleration $a$, or a force $F$ will produce an acceleration of only $\frac{1}{2}a$. Similarly, if the original mass $M$ be acted upon by a force $2F$, the acceleration will be $2a$. From this it is obvious that the force required must vary as the product of the mass and the acceleration, that is,

$$F = M\,a \qquad (1)$$

Next, consider a freely falling body of mass $M$ acted upon only by gravity. At the end of the first second it will have attained a velocity of 32.16 feet per second; at the end of the next second a velocity of

$$32.16 + 32.16 = 64.32$$

feet per second, and so on; that is, a constant acceleration of 32.16 feet per second per second is produced by a force equal to the weight $W$ of a mass $M$, and, according to formula (1), this may be expressed as

$$W = 32.16 \times M$$

from which the mass of a body is seen to be its weight divided by the acceleration due to gravity.

$$M = \frac{W}{32.16} \qquad (2)$$

Reverting to the first case, that of a mass $M$ acted upon by a force $F$ and producing an acceleration $a$, at the end of $t$ seconds the velocity $V$ will be

$$V = a\,t \qquad (3)$$

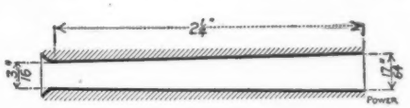
and the average velocity during this period will be

$$\frac{V}{2} = \frac{a\,t}{2}$$

The distance $d$ passed over during $t$ seconds will equal the average velocity multiplied by the time:

$$d = \frac{V}{2} \times t = \frac{a\,t^2}{2} \qquad (4)$$

The kinetic energy of a body in motion




SECTION THROUGH NOZZLE

is equivalent to the work done upon it, which equals the force multiplied by the distance through which it acts. Denoting the kinetic energy by $K$,

$$K = F \times d \qquad (5)$$

Substituting the values from equations (1), (3) and (4),

$$K = M \times a \times \frac{a\,t^2}{2} = M \times \frac{V^2}{2}$$

But from (2),

$$M = \frac{W}{32.16}$$

Hence,

$$K = \frac{W\,V^2}{64.32}$$

or the kinetic energy of one pound of any body in motion equals

$$\frac{V^2}{64.32} \qquad (6)$$

Having established this relation between the energy and the velocity of a body the flow of steam may be considered. If steam be allowed to expand from a higher to a lower pressure without doing external work, and its flow is unrestricted, the heat given up during expansion is transformed into kinetic energy, imparting velocity to the steam itself. The expansion in this case is said to be adiabatic and the quality at the lower pressure is less than at the higher. Denoting by $H$, the heat above 32 degrees Fahrenheit, in one pound of steam at the initial pressure $p_1$, and the heat in the same pound of steam after expansion to a lower pressure $p_2$, by $H_2$, the heat given up during the adiabatic expansion from $p_1$ to $p_2$ is

$$H_1 - H_2$$

Since this heat drop is converted into kinetic energy and since one British thermal unit is equivalent to 778 foot-pounds, the kinetic energy of one pound of the steam may be expressed as

$$K = \frac{V^2}{64.32} = 778\,(H_1 - H_2)$$

or,

$$V^2 = 64.32 \times 778\,(H_1 - H_2) \qquad (7)$$

In a nozzle the expansion of the steam is not strictly adiabatic since the friction against the walls of the nozzle causes the steam to give up some heat. This heat (neglecting radiation which is small) is not lost but is given back to the oncoming steam and raises its quality; hence the quality at exit from a nozzle is slightly higher than that shown in the steam tables for adiabatic expansion.

This heat, however, does detract from that which is convertible into kinetic energy. In view of this, it is necessary to slightly modify formula (7). Assuming the loss due to friction to be 10 per cent., this expression would be

$$V^2 = 64.32 \times 778 \times 0.90\ (H_1 - H_2)$$

or,

$$V = \sqrt{64.32 \times 778 \times 0.90 (H_1 - H_2)} \quad (8)$$

With this as a basis the following problem may be solved:

*What are the proportions of an expanding nozzle having a throat 3/16 inch in diameter, receiving dry saturated steam at 80 pounds gage and expanding to atmosphere? Also, what weight of steam will flow per second and what will be the velocity of the steam at exit?*

That portion of a nozzle constituting the throat, for all practical purposes, may be considered as an orifice and the flow calculated accordingly. It has been proved experimentally that when steam expands through an orifice the pressure in the orifice cannot fall below 0.58 of the initial pressure. Furthermore, with the exit pressure bearing approximately this relation to the initial pressure, the flow through the orifice has been found to conform to the expression

$$W = \frac{p_1 A_1}{70} \quad (9)$$

Where,

$W$ = Weight of steam flowing per second in pounds;

$p_1$ = Initial absolute pressure; in this case 94.7

$A_1$ = Area of orifice in square inches; in this case 0.02761, corresponding to a diameter of 3/16 inch.

Substituting these values in formula (9),

$$W = \frac{94.7 \times 0.02761}{70}$$

$$W = 0.03740 \textit{ pound per second}$$

Now considering the nozzle as a whole, to determine the velocity of the steam at exit apply formula (8). From the steam tables or a temperature-entropy chart the total heat in one pound of dry saturated steam at 94.7 pounds absolute is found to be 1185 B.t.u., and after adiabatic expansion to atmospheric pressure it contains 1047 B.t.u. Hence,

$$V = \sqrt{64.32 \times 778 \times 0.90\ (1185 - 1047)}$$
$$= 2490 \textit{ feet per second}$$

If allowed to expand adiabatically from 94.7 pounds to atmospheric pressure the quality at exit would have been 89.5 per cent., but taking into consideration the heat of friction returned to the steam the quality at exit would be found as follows. The latent heat of vaporization at atmospheric pressure is 970.4 and the heat of friction returned to the steam was

$$0.10\ (H_1 - H_2) = 0.10\ (1185 - 1047)$$
$$= 13.8 \textit{ B.t.u.}$$

Then the increase in quality would be

$$\frac{13.8 \times 100}{970.4} = 1.42 \textit{ per cent.}$$

and the final quality would be

$$89.5 + 1.42 = 90.92 \textit{ per cent.}$$

Denoting the cross-sectional area of the exit of the nozzle by $A_2$, the weight of steam flowing by $W$ and the density (cubic feet per pound) at atmospheric pressure and 90.92 per cent. quality by $v_2$,

$$W = \frac{A_2 V}{144\ v_2}$$

The volume of one pound of dry steam at atmospheric pressure is found from the steam tables to be 26.79 cubic feet. Therefore, at 90.92 per cent. quality a pound of steam at this pressure would occupy

$$0.9092 \times 26.79 = v_2 = 24.3 \textit{ cubic feet}$$

The value of $W$ was previously found to be 0.0374 pound and $V$ to be 2490 feet. Substituting these values,

$$0.0374 = \frac{A_2 \times 2490}{144 \times 24.3}$$

or,

$$A_2 = \frac{0.0374 \times 144 \times 24.3}{2490} =$$

$$0.0526 \textit{ square inch}$$

This corresponds to a diameter of 17/64 inch.

The ratio of length to diameter (at the throat) of nozzles differs widely among different manufacturers, but a ratio of 12 to 1 is considered by many to be good practice. Therefore, the dimensions of the nozzle under consideration would be as shown in the illustration.

## A New Process of Water Softening

The "zeolites" are distributed pretty freely among the older rocks of the earth's surface, though not entering into the constitution of the rocks themselves. They are found in a crystalline form in amygdaloidal fissures or cavities of trap or plutonic rocks, where they have apparently been deposited from water which has percolated into the cavities, thus probably being products of decomposing nepheline, or felspar, or hydrated felspars themselves. They are composed generally of varying quantities of silica, alumina, lime, soda, potash and water, the silica always largely predominating in all forms, though the other constituents are not necessarily found in all "zeolites." As an example of one form take analcime, which is composed of 54.5 per cent. of silica, 23.3 per cent. of alumina, 14.1 per cent. of soda, and 8.2 per cent. of water. These zeolites have, in contradistinction to other silicates occurring in nature, the property of being soluble, and they also decompose in dilute acids. They have also the very important property of being able to exchange their bases for others.

It has been found that when hard water is allowed to filter slowly through layers of these hydrated silicates of alkalies the lime in the water changes place with the soda in the filtering medium, and the water passes out softened; and this fact has been the means in Germany of instigating a series of experiments during the last two years, which have proved of great value, and which have shown that these zeolites can be produced artificially, with the result that the substance is now made much more regular in its composition and freer from impurities than that found in a state of nature. To these artificial zeolites has been given the name of "permutit," which in a moist condition is of a granular flaky form, and has a luster like that of mother-of-pearl. It has a high porosity, and in the dry state readily absorbs about 50 per cent. of water. It is obtained by fusing together felspar, kaolin, clay and soda in definite proportions, the resultant material being lixiviated with hot water, when permutit is left as a residue. The granular material is freed as much as possible from the final alkaline lye by washing and centrifugal action.

In *Engineering* the use of this material for softening water is briefly described as follows: The total hardness of water may consist of temporary hardness or of permanent hardness, or of the two combined, the former being caused by calcium and magnesium carbonates, and the latter by other salts of lime and magnesia. Boiling at atmospheric pressure precipitates the carbonates and the magnesia, but not the salts forming permanent hardness. In commercial processes at the present time, sodium carbonate is added to water as a means of precipitating the hardening constitutents of the water, there being an exchange of bases between the lime and manganese and the sodium carbonate. In like manner, if hard water be allowed to filter slowly (the slower the better) through layers of permutit, there is likewise an exchange of bases, the lime in the water taking the place of the soda in the permutit, one molecule of calcium bicarbonate being converted (in the case of temporary hardness) into two molecules of sodium bicarbonate, which latter remains in the water, being very soluble. The permutit in the filter will only retain this power so long as any soda remains to exchange with the lime in the water. Permutit suffers practically no loss during use, but when a certain amount of water has been passed through it, its softening powers disappear, but they can easily be restored, and the material can be used over and over again practically indefinitely.

The power of regeneration appears to be the chief novelty of the process; but before it is carried out a few essential

points must be attended to. In the first place, the filter must be cleaned. Experience shows that filtration is most effective from the top to the bottom, and that, therefore, cleaning should take place in the reverse direction—namely, from the bottom to the top—so as to loosen the mass and remove any air that has collected in the material, soft water, if possible, being used for the purpose. After washing, the permutit is regenerated by a solution of common salt, the solution generally being of 10 per cent. strength. Previous to regeneration all water is removed from the filter down to the layer of permutit, after which the salt solution is introduced and allowed to flow slowly through the filter for from four to five hours. In addition to this, the brine is allowed to stand for a further four or five hours, just covering the layer of permutit, after which the filter is filled with water from the top, and an outlet cock at the bottom is opened for 20 or 30 minutes, or until the water no longer shows any hardness with ammonium oxalate or with soap solution.

The chemical reaction that takes place during regeneration consists in an interchange between the soda in the sodium chloride and the lime in the permutit (derived from the water which it has softened), calcium chloride remaining in solution in the regeneration water. It may be stated that in practice the most suitable rate for the water that requires softening to pass through the layers of permutit has been found to be from 13 to 17 feet per hour. The permutit is not only active at the surface, but also in the interior, in consequence of its porosity.

From information supplied from Germany it appears that filters using these artifical zeolites have been in practical use during the last two years, treating water for a variety of purposes, including use in boilers and for washing fine textile goods, and a plant has recently been installed in England for the latter purpose with satisfactory results.

In one case where a permutit filter was supplied to a steam laundry in Berlin more than two years ago, it is stated that in about nine months 1,174,800 gallons of water passed through the filter, which volume was completely softened without any apparent loss of permutit. The charge of permutit was about half a ton, and about 1050 gallons of water passed over each pound of the material. In this case about 44,000 gallons of water per week were used, and regeneration was carried out twice per week, 88 pounds of salt being used per regeneration, although it is stated that it need not have been done quite so often. The cost of regeneration naturally depends on the price of salt, and on the degrees of hardness in the water. It is stated that water having 53 degrees of hardness has been reduced to 3.7 degrees by the process.

The system is now being introduced into England by Water-Softeners, Limited, 20 Copthall avenue, Throgmorton street, E. C., London.

## A Record Breaking Turbine Test

The following results of a test conducted upon a 6000-kilowatt turbine at the Dunston power station of the Newcastle-upon-Tyne Electrical Supply Company are reproduced from *Engineering* of March 10. The turbine is of the Parsons type, having separate high- and low-pressure casings. It was designed to have its maximum economy at 9000 brake horsepower, with steam at 190 pounds gage and at 190 degrees superheat. In the test the superheat did not exceed 176 degrees Fahrenheit, but the vacuum was high, the absolute pressure in the condenser being 0.90 inch of mercury. This is 249.4 B.t.u. per kilowatt-hour with 90 per cent. generator efficiency corrected for condenser leakage which is 76.4 per cent. efficiency referred to the Rankine cycle, and the best of which we have learned. The test was conducted by Messrs. Merz and McLellan, consulting engineers to the Newcastle company.

The official steam-consumption trials of this plant were run on December 16, 1910. The contractors to the company for the complete unit were Messrs. Brown, Boveri & Co., Ltd., London.

Details of the plant are given in the accompanying Table 1.

TABLE 1

| | |
|---|---|
| *Turbo-Alternator:* | |
| Normal output | 6250 kw. |
| Speed | 1200 r.p.m. |
| *Turbine:* | |
| Specified most economical load | 9000 b.h.p. |
| Type | Two-cylinder Parsons |
| Type of blading | Reaction |
| Arrangement of steam passage | H.-P. cylinder uni-flow; L.-P. cylinder, partly uni-flow, partly double flow |
| Specified steam pressure | 190 lb. per sq.in. |
| Specified superheat | 190 deg. Fahr. |
| *Alternator:* | |
| Type | Rotating field, three-phase |
| Continuous output | 7000 k.v.a. at 0.9 power factor |
| Voltage (terminal) | 5750 volts |
| Exciter | Direct-coupled self-excited |
| *Condensing Plant:* | |
| Surface | 13,000 sq.ft. |
| Type | "Contraflo" |
| Diameter of tube, external | ¾-in. |
| Thickness of tube | 18 B.W.G. |
| Allowable circulating water per hour | 630,000 gallons |
| Specified circulating-water inlet temperature | 50 deg. Fahr. |
| *Air-Pumps:* | |
| Type | Edwards three-throw, motor-driven |
| Capacity | 3.68 cu.ft. per barrel |
| Volume swept through per minute by air-pump plungers | 1660 cu.ft. per min. |
| *Augmentor:* | |
| Surface | 400 sq.ft. |

Preliminary unofficial trials were run on December 14 and 15 at various vacua and at various superheats, to determine the corrections to be applied to actual figures in order to enable the actual results to be compared with those specified.

The results of the official trials are given in Table 2.

TABLE 2

| Trial. | 1 | 2 | 3 |
|---|---|---|---|
| Date | Dec. 16 | Dec. 16 | Dec. 16 |
| Duration | 9 a.m. to 10 a.m. | 11.30 a.m. to 1 p.m. | 2.30 p.m. to 4.40 p.m. |
| Output from generator to busbars (true kilowatts) kw | 4256 | 5600 | 6257 |
| Speed, r.p.m. | 1210 | 1210 | 1210 |
| *Steam Quality* | | | |
| Pressure at boiler side of turbine stop-valve by gage, lb. per sq. in. | 192 | 189 | 189 |
| Temperature of steam at boiler side of turbine stop-valve, deg. F. | 546 | 549 | 559 |
| Superheat, deg. F. | 162 | 166 | 176 |
| *Exhaust* | | | |
| Pressure (abs.) in condenser in. Hg., in | 0.81 | 0.88 | 0.90 |
| Temperature in condenser, deg. F. | 73 | 75 | 76 |
| *Circulating Water System* | | | |
| Temperature, inlet, deg. F. | 44 | 44 | 44 |
| Temperature, outlet, deg. F. | 50 | 52 | 53 |
| *Steam Consumption* | | | |
| Total water used per hour, lb | 52,907 | 67,950 | 75,000 |
| Water used per kilowatt-hour, lb. | 12.4(4) | 12.1(4) | 11.9(7) |
| Water used per kilowatt-hour corrected for condenser leak'ge, lb. | 12.4(2) | 12.1(2) | 11.9(5) |
| Steam consumption corrected for 190 deg. F. superheat and 29.1 in. vacuum, lb. per kw.-hr. | 12.1(5) | 11.8(5) | 11.8(0) |

REMARKS

1. *Change of Load.*—An interval of 1½ hours was allowed between changes of load.
2. *Output.*—Measured by integrating wattmeter specially calibrated for the purpose.
3. *Steam Condensed.*—Weighed by the permanent weigh-tanks installed in the power-station.

The total output of the Rumanian oilfields for 1910 is now stated by the *Moniteur du Pétrole Roumain* at 1,352,300 tons. This is an increase of over 55,000 tons, or 4.3 per cent., over the 1909 figure. The totals of the various companies are of more particular interest. The Steana Romana fell off 27,800 tons, but still heads the list with an output of 410,250 tons. The Astra Romana comes next with an output of 287,300 tons and an increase of over 26,000 tons; then the Romano Americano with 145,300 tons (increase 24,800 tons). The Concordia fell off by 16,700 tons, but comes fourth on the list with an output of 95,600 tons; and lastly follow the Orion, 61,400 tons (increase 12,700 tons) and the Regatul Roman, 53,600 tons (decrease 28,400 tons).

# The Small Turbine in Marine Work

On shipboard the space occupied by and the weight of the mechanical equipment are two extremely important factors, more important, oftentimes, than the first cost and economy in operation. Perhaps most important of all, however, is reliability of service. The development of the small turbine has made possible wonderful progress in economy of space and weight besides producing simplicity and dependability in operation. To show the extent to which this type of prime mover is being applied in marine practice, some of the uses to which it is put are specified below.

*The small turbine is being used extensively for such service as pumping, lighting, ventilating and forced draft, particularly in the United States navy where reliability is equal in importance to economy of space and weight. For forced-draft work the turbine has been especially successful.*

The Hudson River Day Line boats are each equipped with a turbine-driven centrifugal pump for use in trimming ship. When a boat is making a landing the passengers crowd to one side, causing it to list. This oftentimes seriously interferes with the steering and manipulation of the boat. To keep the boat on a level keel on such occasions two large tanks were built in amidships so that one

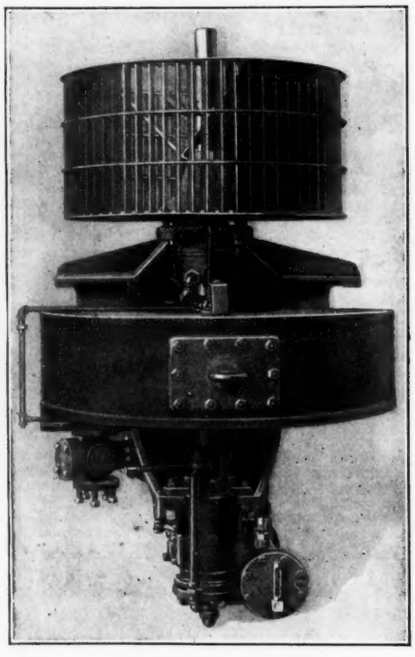


FIG. 1. FORCED-DRAFT SET FOR TORPEDO-BOAT DESTROYERS

or the other may be filled with river water whenever it is desirable.

The pump is 8 inches in size and is driven by a 15-horsepower single-stage Terry turbine at a speed of 1800 revolutions per minute. These ballasting sets are guaranteed to develop their full capacity of 1000 gallons per minute within 20 seconds from the time of opening the throttle. The outfit is set down in the hold but it is operated from the engineer's platform so that the engineer may start the filling of a tank the instant that he sees the telltale arrow shift.

A use to which the turbine is now commonly being put is the driving of dynamos to furnish current for lighting, ventilating and other purposes. The United States Navy is particularly progressive in this respect. The flagship "Connecticut" has four 100-kilowatt turbo-generator sets and twelve revenue cutters are equipped with turbo-generators of capacities ranging from five to seven kilowatts.

At Boston the municipal fireboat, "George A. Hibbard" is fitted with a multistage centrifugal fire pump driven by a 100-horsepower turbine.

The most important application of the small turbine in marine work has been its adoption for forced draft. The use of turbines for forced draft has been extensive in the Navy where a continuous and sufficient air supply is always of first consideration. Fig. 1 shows a forced-draft set which is used on the new torpedo-boat destroyers "Roe," "Terry,"

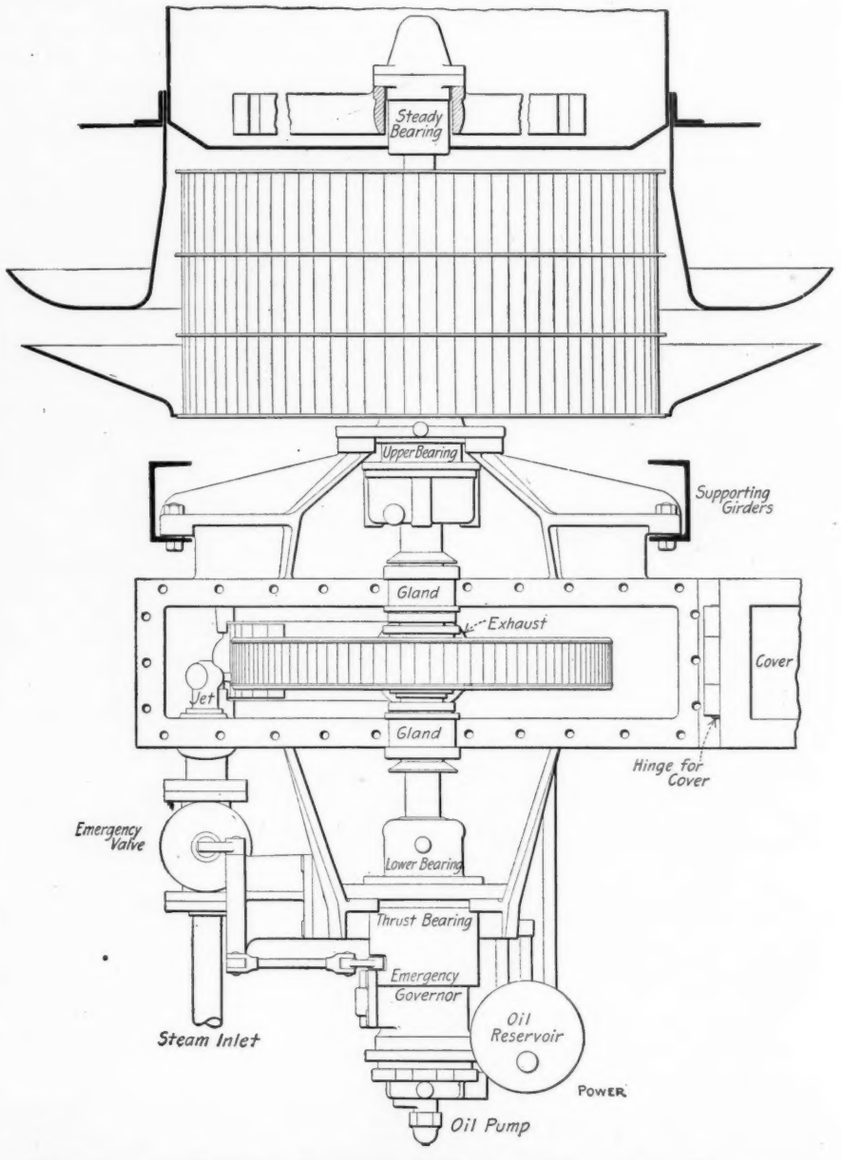



FIG. 2. GENERAL DESIGN OF FORCED-DRAFT SET FOR TORPEDO-BOAT DESTROYERS

"Paulding" and "Drayton." The five destroyers, "Monoghan," "Fanning," "Jouett" and "Jenkins" which are now being built will also have sets of the same design. A set consists of a Terry single-stage vertical turbine and a Sirocco fan which has a 30-inch runner. Two sets are placed in each of the two stoke holds and each set delivers from 23,000 to 25,000 cubic feet of free air per minute at a pressure of from 3½ to 5 inches of water; the speed is about 1400 revolutions per minute.

Fig. 2 shows the general design of the set illustrated in Fig. 1. One feature of this design is that the entire unit, completely assembled, can be dropped through the ventilator which is 40 inches in diameter. The whole apparatus is so arranged that it can be mounted on I-beams suspended from the deck or bulkheads. The fan wheel itself is on a line with the deck immediately at the foot of the ventilator. The main casing of the turbine is divided vertically along the center line and the cover is fitted with a hinge so that the casing can be opened without the use of a crane or the removal of any of the parts.

The weight of the whole runner is carried by a ball bearing which is always kept flooded with fresh oil. The step bearing is in the lower bearing housing; below it is fitted an emergency governor of the unstable type which, when the weights fly out, releases a trigger which in turn allows the automatic stop valve to close, the valve being primarily kept open against a powerful spring.

At the extreme lower end of the shaft is fitted a small geared oil pump. This pump consists of two ordinary gear wheels, and is so designed that it will give a sufficient supply of oil to all of the bearings at any speed. A combined relief and bypass valve is placed between the suction and the discharge and set at a given pressure; thus, at low speeds the pump will deliver oil to the bearings at the same pressure as at high speeds. All of the oil is drained back from the bearings to a common reservoir; the position of this reservoir is slightly above that of the oil pump.

On the destroyers "Warrington," "Myrant," "Lawrence," "McCall" and "Burrows" sets composed of the same make of turbine and a special Sturtevant fan are used. The "Patterson" and "Ammen," now building, will be similarly equipped. The fans for these sets are of the standard Sturtevant design, except that the blades have a special contour in order to secure the greatest possible efficiency at the speed used.

It is a noteworthy fact that all of the destroyers which have been equipped with this type of forced-draft apparatus have gone through their acceptance trials without the slightest trouble due to lack of sufficient air or interruption of service from the blowers.

# Steam Line Conduit of Low Cost

By Henry G. Pope

In connection with the installation of a steam power-plant equipment, it was necessary to arrange a steam line to connect the boiler house with the pump house shown in Fig. 1. The connection was to be a temporary one, to be replaced ultimately with a permanent and a larger pipe. Methods of carrying the line overhead were considered but were abandoned because of the radiation losses involved and because of the expense of erecting a supporting structure that would be strong enough to be reasonably safe against breakdown.

Several designs of conduit construction were considered, but the one suggested in Fig. 2 was finally adopted because of its low cost and ease of installation. It appeared to be sufficiently substantial to give good service for the few years that it would be in use. The conduit, Fig. 2, was constructed from rough pine planks held together with common steel spikes. Joints between all plank ends were broken and a piece of waterproofed building paper was tacked over each joint in the roof. All of the planks forming one of the sides of the conduit were wider than those forming the other, so that the roof plank would have a pitch to better enable it to shed water that percolated through the soil. In building the conduit, the three lower planks, *A*, *B* and *C*, Fig. 2, were assembled in trough-like sections and lowered into the trench and the ends of the sections were there spliced together. After the pipe had been laid in, the cover plank was nailed on and the trench refilled with earth.

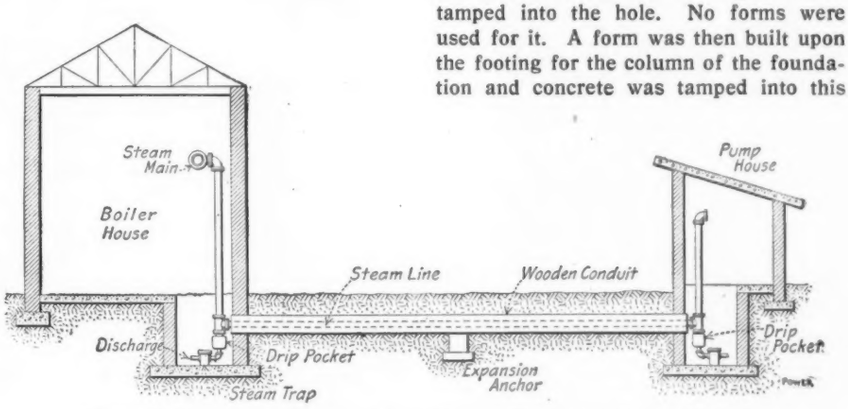



Fig. 1. Layout of Piping between Steam Main and Pump House

Bricks were used to support the pipe in the conduit. Supports of several other forms were considered, but all were abandoned in favor of the brick type, because of its simplicity and low cost. Four bricks were used at each point of support, the distance between supports being about 10 feet. Two bricks (see Fig. 2), laid on their sides on the bottom plank of the conduit, prevented the pipe from touching it and two more bricks, each resting on its end, kept the pipe centered laterally. To prevent the bricks from shifting, due to the expansive and contractive movements of the pipe, several spikes were driven into the bottom planks around the bricks.

Although it is not shown in Fig. 1, the pipe line and conduit had a slight downward pitch toward the pump house, so that all condensation would flow with the steam that way. A drip pocket, drained by means of a steam trap of the bucket type, was provided at each end

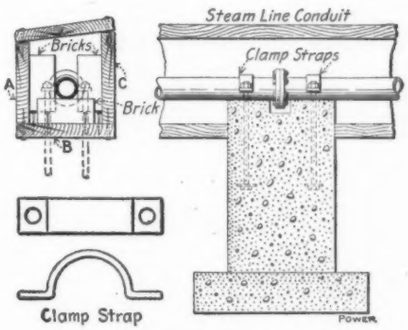



Fig. 2. Details of Conduit

of the conduit. Fig. 1 shows the details of this arrangement, which was practically the same at both ends.

Expansion was provided for wholly in the vertical portions of the steam pipe in the buildings at the ends of the conduit. The steam pipe was clamped to an anchor, located midway between the buildings. The details of the anchor are given in Fig. 2. In constructing the anchor a square hole with dimensions equal to those of the footing was excavated. The concrete footing was then tamped into the hole. No forms were used for it. A form was then built upon the footing for the column of the foundation and concrete was tamped into this form. Wrought-iron foundation bolts were cast in the concrete. Clamping straps, details of which are shown in Fig. 2 held the steam pipe firmly to the foundation and prevented any movement at that point. Ordinary nuts, turning on the foundation-bolt ends, secured the straps.

# Electrical Department

*Especially conducted to be of interest and service to the men in charge of the electrical equipment*

## Automatic Starters for Induction Motors

By R. H. Fenkhausen

Automatic starters for induction motors are much more expensive than hand-operated starters, of course, but there are many installations where the saving in attendance or in other installation and maintenance costs will justify the extra first cost of automatic starters. For the control of a motor-driven pump delivering water into a tank in which the water level must be kept within certain limits, or for the control of a motor-driven compressor the receiver pressure of which must be maintained fairly constant, the automatic starter is almost indispensable.

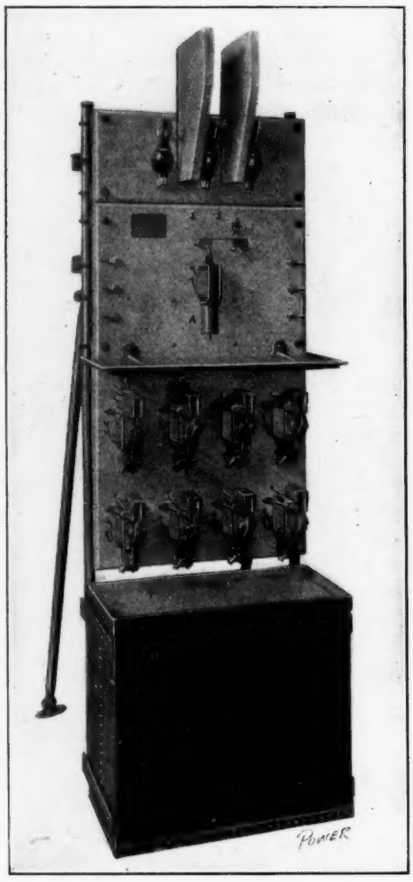


Fig. 1. Three-phase Starter for Squirrel-cage Motors

Where motor attendants are unskilled or careless, automatic starters make it possible to limit the starting current and acceleration of each motor, because once the operator has closed the small switch in the control circuit, the starter automatically performs the several operations of starting the motor with a predetermined interval of time between each operation and the operator is powerless to shorten the starting period.

There are many cases where it is not practicable to install a motor near the place where it must be controlled and it often happens that the extra expense of an automatic starter is offset by the saving in wiring. When the automatic starter is used, it may be located close to the motor and the actual control accomplished by a small snap switch in the solenoid circuit of the starter. As two very small wires only are needed to connect the snap switch with the starter, there is a considerable saving in installation time and material over that required to carry the main wires from the motor to the control point.

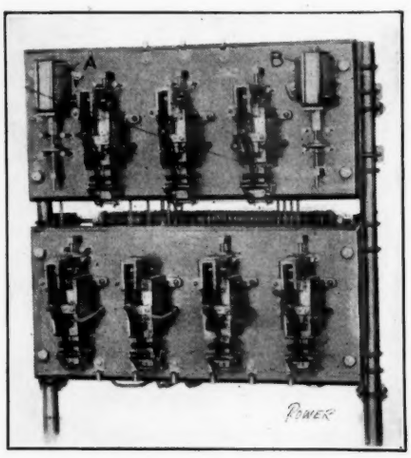


Fig. 2. Three-phase Starter for Wound-rotor Motors

If the distance from the motor to the point of control is very great, there is also a saving of energy due to the fact that there is less wire in the power circuit and therefore less loss due to resistance. This applies particularly to wound-rotor induction motors with external starting resistors, because, in addition to the line wires, these motors require three leads of large capacity from the controller to the collector rings and if the distance from the motor to the controller is very great, the loss due to the drop in the secondary wiring will be excessive. The use of the automatic starter in such a case not only results in a marked reduction in installation costs but also improves the efficiency and speed regulation of the motor.

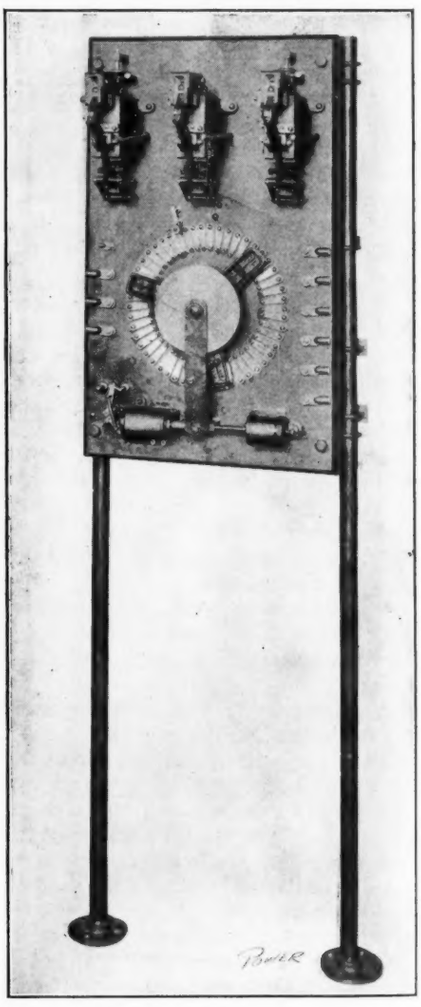


Fig. 3. Automatic Starter for Gradual Acceleration

### General Functions

Figs. 1, 2 and 3 show automatic starters which may be controlled in several ways. For remote hand control a snap

switch is placed at the desired control point and connected in the main solenoid circuit of the starter.

Where automatic acceleration alone is required, the main solenoid circuit may be permanently closed and the motor started and stopped by a switch connected in the main motor circuit at any point between the motor and the entrance of the service wires, or the main circuit may be left closed and a pilot switch used as for remote control. The latter method is preferable unless the line switch is of the oil-break type, but the choice between the two methods will naturally be governed by the wiring layout. If the point of control is close to the run of the motor circuit one method is as good as the other, but if the control point is not located near any point on the supply circuit, the saving in wiring will make the use of the pilot switch advisable.

When automatic starters are controlled by float switches or pressure governors,

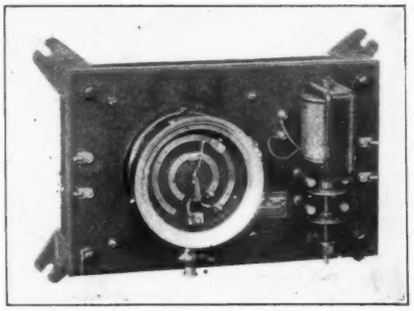


FIG. 4. RELAY FOR CONTROL BY PRESSURE CHANGES

these are invariably connected in the main solenoid circuit, because their contacts are small and therefore not adapted for connection in the motor circuit where heavy currents must be controlled.

The pressure governor shown in Fig. 4 consists of a standard bourdon pressure-gage mechanism provided with two contact rings to which adjustable contacts may be clamped at any point. These contacts and the end of the gage pointer are silver tipped to prevent corrosion. The contacts are too small to carry even the main solenoid current of the starter, so a relay is interposed between the gage contacts and the solenoid circuit. When the pressure falls below the lower limit set, the end of the gage pointer makes contact with the sliding block on the inner ring and thereby closes the energizing circuit of the relay solenoid shown at the right, which raises its plunger, bringing the disks into contact with the two pairs of terminals above them; this closes the solenoid circuit of the automatic starter and short-circuits the contact made by the pointer and the inner ring. When the pressure rises to the upper limit, the gage pointer makes contact with the sliding block on the outer ring and short-circuits the relay magnet, which drops its core and opens the solenoid circuit of the starter at the lower disk contacts, shutting down the motor. The gage contacts never break any current, because the upper disk of the relay short-circuits the contact made by the pointer with the block on the inner ring; consequently, when the rising pressure moves the pointer away from the inner

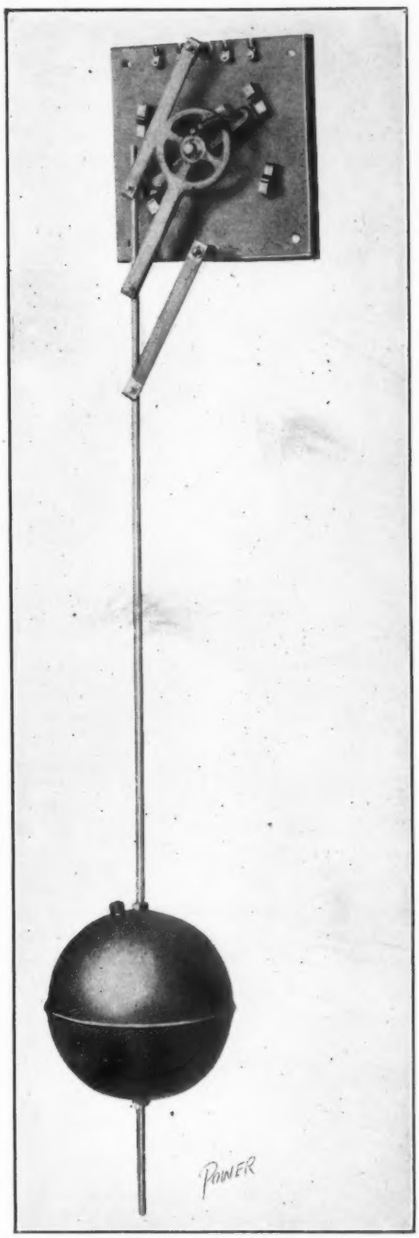



FIG. 5. COMPLETE TANK SWITCH, FLOAT AND ROD

contact, the circuit remains closed at the upper disk. The motor continues to run until stopped as described. (See also the relay connections in Fig. 8.)

Fig. 5 shows a float switch designed to be clamped on the edge of a tank. Adjustable collars on the float rod actuate the switch which controls the solenoid circuit of the automatic starter, and by setting the collars to operate the switch at the desired water levels the hight of water in the tank may be kept within the limits of those levels. It is desirable that there be as great a difference as practical between the upper and lower levels in order that the pump and motor shall not be started and stopped too frequently. When it is not possible to locate the float switch at the edge of the tank, on account of exposure to the weather or other conditions tending to interfere with its operation, a float switch of the type shown in Fig. 6 may be used; this is operated by a rope passed over guide pulleys, with a counterweight on the end opposite to the float.

### STARTER OPERATION IN DETAIL

Fig. 1 shows an automatic starter for squirrel-cage induction motors in which the various contacts are made and broken by "contactors," or electromagnet

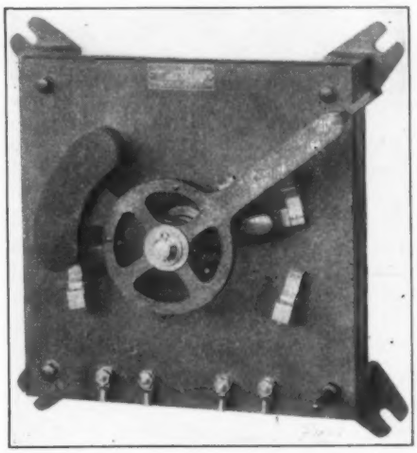


FIG. 6. FLOAT SWITCH FOR OPERATION BY ROPE

switches, under the control of relays. In the starter shown, the contactors are arranged for submersion in an oil tank for 2200-volt service, but for lower voltages the oil tank is omitted. The operation of this starter is as follows (see Fig. 7):

When the control circuit is closed, the relay *A* and the contactor magnets 1 to 5 are energized; the contactors connect the autotransformer coils across the line with the motor connected to the low-voltage taps. The relay *A* lifts its plunger against the retarding influence of a dashpot that is adjustable so as to vary the duration of the starting period of the motor. When the plunger reaches its limit of upward travel the control circuit of the contactors 1 to 5 is opened by means of the small switch shown above the relay in Fig. 1 and another circuit is closed which energizes the magnets of the contactors 6 to 8; these connect the motor directly to the line.

No-voltage protection is provided by the relay *A* and the contactors 6 to 8, which open on failure of the current sup-

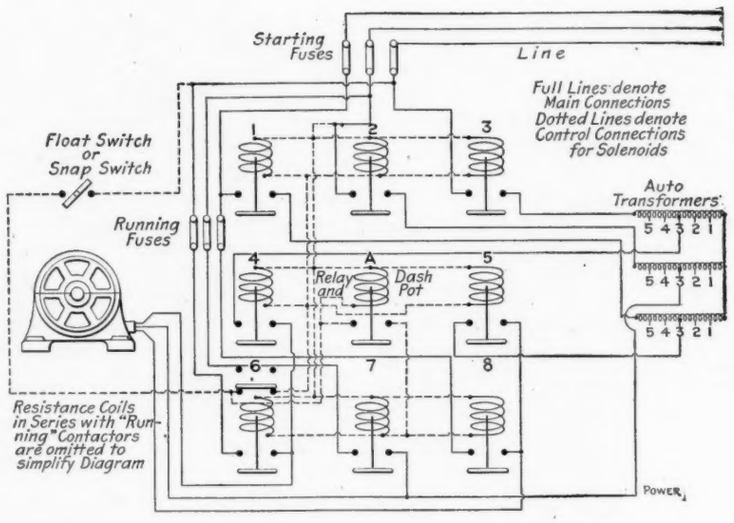

Starting Fuses
Line
Full Lines denote Main Connections
Dotted Lines denote Control Connections for Solenoids
Float Switch or Snap Switch
Auto Transformers
Running Fuses
Relay and Dash Pot
Resistance Coils in Series with "Running" Contactors are omitted to simplify Diagram
Power

FIG. 7. DIAGRAM FOR STARTER IN FIG. 1 AND FLOAT SWITCH

ply, leaving the starter ready to start up again in the usual manner as soon as the current supply is resumed. The motor is stopped by opening the main control circuit.

The automatic starter shown in Fig. 2 is for use with induction motors of the wound-rotor type. Its construction is similar to that illustrated in Fig. 1, but two starting points are provided by variation of the resistance in the rotor circuit. The operation of this starter is as follows (see Fig. 8): When the control circuit is closed, the shunt coil of the compound-wound relay *A* lifts its plunger, which closes the magnet circuit of the contactors 1, 2 and 3; these connect the stator winding of the motor to the line, leaving all of the resistor in the rotor circuit. The contactor 1, in closing, also opens the shunt-coil circuit of the relay *A*, leaving its plunger held by the series coil. This series winding is proportioned so that as soon as the starting current of the motor falls below a certain value the coil will drop the plunger and close the operating circuit of the contactors 4 and 5; these cut out part of the rotor resistor and the contactor 4 also opens the shunt winding of the compound-wound relay *B*, leaving its plunger held by the series coil alone. When the starting current has fallen below the value for which the relay *B* is designed, this relay drops its plunger and closes the operating circuit of the contactors 6 and 7 which cut out the remainder of the rotor resistor and short-circuit the collector rings of the motor; the contactor 6 in closing also opens the operating circuit of the contactors 4 and 5, which therefore open their contacts. Overload during the starting period is prevented by the setting of the relays *A* and *B* and no-voltage protection is provided by the contactors 1, 2 and 3, which drop out and restore the starting conditions upon failure of the current supply.

The automatic starter shown in Fig. 3 is for use in service requiring a more even acceleration than is afforded by two starting points. A solenoid-operated ratchet switch of the dial form automatically cuts out the resistor in the rotor circuit little by little and the large number of contacts provided on the dial gives a very uniform rate of acceleration.

For small squirrel-cage motors, of less than 20 horsepower, the starter shown in Fig. 1 is often too costly and small self-contained starters of the types illustrated by Figs. 9 and 10 are applicable. The one shown in Fig. 9 is designed for operation by means of a rope connecting with a large float in a tank supplied by a motor-driven pump. The sheave around which the rope passes is loose on the starter shaft and its periphery is slotted through a large arc to permit a considerable movement of the sheave (due to change in water level) before moving the weight arm, which passes through this slot. When the water level falls, the rope attached to the float rotates the sheave in the clockwise direction until

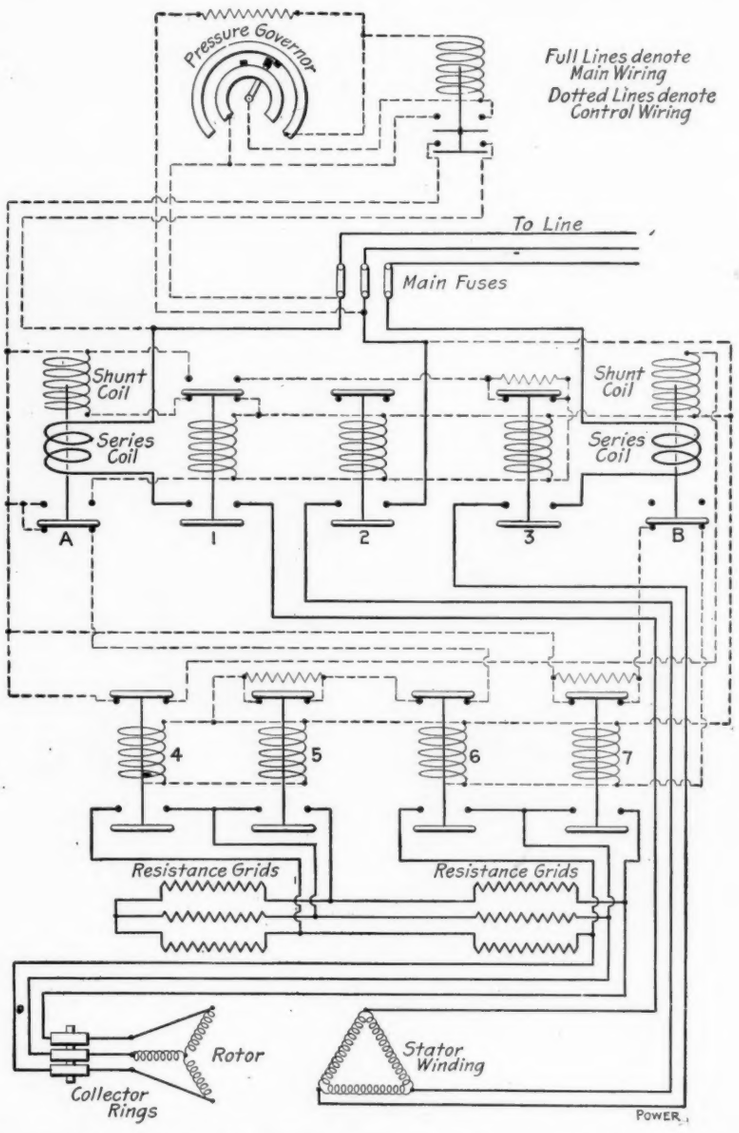



FIG. 8. DIAGRAM FOR STARTER IN FIG. 2 AND PRESSURE RELAY IN FIG. 4

the end of the slot engages the weight arm, which is flexibly connected to the drum switch within the case; continued drop in the water level allows the float to pull the sheave around farther and

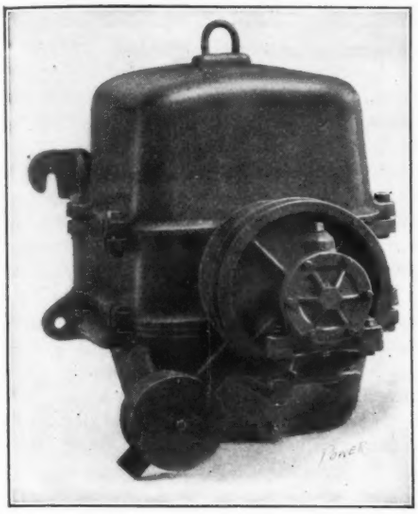


FIG. 9. SMALL STARTER ACTUATED BY FLOAT AND ROPE

carry the weight arm over the top center, from which position it falls by gravity, retarded by a dashpot, and operates the starting switch, accelerating the motor at a rate determined by the dashpot adjustment. As the water level rises, the float is lifted, of course, and rotates the sheave in the opposite direction until the weight arm is carried over the top center, from which position it falls quickly, making a quick break at the main switch contacts and shutting down the motor.

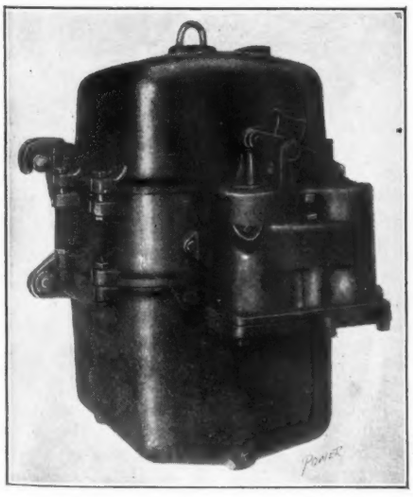


FIG. 10. SMALL STARTER ACTUATED BY PRESSURE RELAY

The starter of Fig. 10 is equipped for operation by pressure variation under the control of a pressure governor. When the tank pressure falls below that for which the governor is set, pressure is admitted to the right-hand cylinder of the starter; the piston in that cylinder rises and operates the starter drum within the case, at the same time compressing a spring in the left-hand cylinder. The rate of acceleration of the motor is controlled by an adjustable dashpot in the left-hand cylinder which acts in opposition to the piston in the pressure cylinder. When the tank pressure exceeds that for which the governor is set, the pressure in the right-hand cylinder is relieved and the starter spindle is turned to the "off" position by the spring in the left-hand cylinders; the movement in this direction is very rapid, being unrestrained by the dashpot.

Each of these starters consists of a standard three-point autotransformer and drum switch, with the addition of the control device described. The connections are shown in Fig. 11. It will be noted that two sets of fuses are employed, one for starting and one for running, but there is no protection against failure of the current supply. If no-voltage protection is desired, a circuit-breaker with a no-voltage trip coil, such as shown in Fig. 12, should be substituted for the running set of fuses.

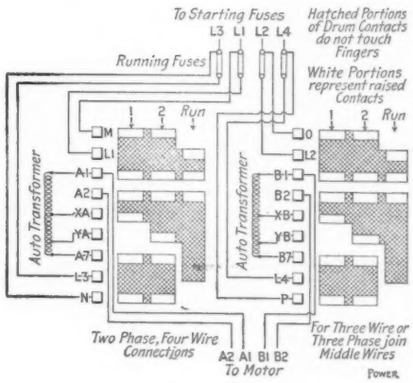



FIG. 11. DIAGRAM OF SMALL STARTERS IN FIGS. 9 AND 10

## SPECIAL CONTROL

All the automatic starters described in this article are built for constant-speed motors. Automatic control for multispeed motors is seldom used except for the larger sizes of motors. These starters are similar to the one described in connection with Fig. 2 except that the starting resistor is designed for continuous service and more starting points are provided. The contactors are under the control of a master switch by means of which those contactors giving the desired speed are held closed. The rate of acceleration and the starting current are out of the operator's control, however, because a relay set for a given starting current operates when the current reaches that value and opens the control circuit of the master switch, preventing any further reduction of the resistance in the rotor circuits until the starting current falls below the limit value.

An interesting example of automatic control as applied to wound-rotor induction motors is that employed in connection with flywheel motor-generator sets. In order that the flywheel may deliver part of its stored energy to relieve the peak load on the motor, it is necessary that the motor shall "lie down" when the load becomes excessive. This is accomplished by the action of a relay set for a given rotor-current value. As soon as the current reaches the value for which the relay is set, its contacts close and energize a series of contactors which cut in resistance in the rotor circuit and reduce the speed of the motor enough to allow the flywheel to give up part of its energy.

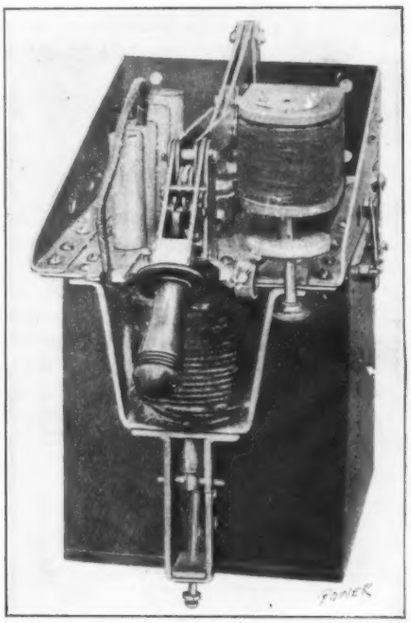


FIG. 12. CIRCUIT-BREAKER WITH NO-VOLTAGE COIL

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The following instructions for raising steam were issued in the annual *Memorandum* of the Manchester Steam Users' Association: Before lighting the fires, see that there is sufficient water in the boiler, also watch the water gage while raising steam, for the blowoff valve or the feed-check valve may be so leaky as to pass water as soon as there is any pressure. that there is sufficient water in the boiler; may produce fractures or start leakages. If the boiler cannot be filled with warm water through the economizer, then the firing should proceed very slowly so that the bottom of the boiler may grow as warm as the top. If pressed for time, the boiler may be filled to the top of the water gages, and when, with rapid firing, the top water has grown warm, discharge the cold bottom water and continue firing the boiler.

# Gas Power Department

*Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men*

## Fitting Trunk Pistons for Gas Engines

By Olaf Olafsen

The methods of fitting pistons to their cylinder bores, the allowances used, the methods of securing these allowances and the reasoning involved may be of value to some engineers who have occasion to do this kind of work or to check up the work of a repair shop. With single-acting trunk pistons there are four sources of possible leakage of compression or of expanding gases: First, due to slight looseness of fit of the piston in a horizontal cylinder during the part of the compression stroke when the connecting-rod thrust is upward, the piston may be canted or cocked in the cylinder bore in such a manner as to disturb the proper bearing of the rings both on their edges and on their faces. Second, if there be a gap between the ends of each ring and if the lands between the rings be reduced too much in diameter, there is an easy passage for the escape of gases under pressure. Third, due to improper proportioning, machining or fitting, the rings may not bear properly over their entire peripheries. Fourth, due to improper machining or fitting they may not have a good bearing on their edges and may allow the gases under pressure to blow under them and out. As a rule, the engineer need consider only the first cause, as the others are due entirely to bad workmanship.

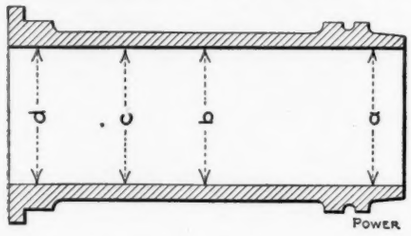



Fig. 1. Reference Diagram for Cylinder Taper

TABLE 1. CYLINDER TAPER.

| Bore, Inches. | Minimum. | Maximum. |
|---|---|---|
| 3½ to 10½ | 0.001 | 0.002 |
| 10½ to 14½ | 0.0015 | 0.003 |
| 14½ to 19½ | 0.002 | 0.003 |
| 20 to 26½ | 0.002 | 0.004 |

Referring to Fig. 1, measure the cylinder at the points *a*, 1¾ inches from the crank end; *b*, midway of the length; *d*, 1¾ inches from the head end; *c*, midway between *b* and *d*. The taper is the difference between *a* and *d*.

First, consider the expansion of the various parts under working conditions, without attempting to theorize upon the actual temperatures that may occur or the differences of temperature between the piston and the cylinder. It will readily be understood that the piston will be somewhat hotter than the cylinder under full-load conditions; therefore, a greater allowance for the running fit must be made than would be necessary were the piston and cylinder always at the same temperature. It is also evident that the head end of the piston will be much hotter than the other end and will therefore have to be turned somewhat smaller than the barrel. Most manufacturers now do not allow the lands between the rings to bear on the cylinder wall when the piston is at working temperature, although some few still adhere to that practice. It is a mistake to relieve the lands too much as it only adds to the tendency to leakage through the gaps at the ring joints.

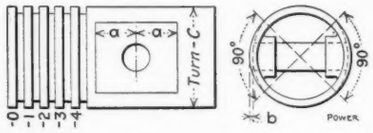



Fig. 2. Reference Diagram for Table 2

There are two practices in turning the lands; some manufacturers turn them of different successive diameters, according to a schedule, and others, starting at the head and there reducing the diameter a specified amount less than the barrel diameter, taper the diameter for a specified distance toward the open end of the piston.

Obviously the breech end of the cylinder, where all the work is done, will be considerably hotter than the crank end if no special precautions are taken to prevent it. It is now common practice to introduce the jacket water under the seat of the exhaust valve or very close to it and discharge the water near the top of the cylinder head, whether the engine be vertical or horizontal; this allows the water to travel with considerable velocity around the hottest parts of the cylinder and to gravitate slowly toward the cooler ones. In some engines the water is first passed through under the exhaust valve, then through the cylinder-head jacket and finally to the cylinder-barrel jacket, thus supplying the latter with warm water and keeping the open end of the cylinder more nearly at the temperature of the breech end. Besides this, it is always the practice in boring cylinders, when reamers are not used, to start the finishing cut at the crank end; the wear of the tool, slight as it may be, almost always causes from o

TABLE 2. PISTON TURNING AND FILING SCHEDULE.

| Bore, Inches. | Piston Barrel, *C*. | Piston Head, *O*. | Lands between Rings. 1 | 2 | 3 | 4 | Dimension *a*. | Dimension *b*. |
|---|---|---|---|---|---|---|---|---|
| 3.75 | 0.0010 | | | | | | 2.25 | 0.001 |
| 4.50 | 0.0010 | | | | | | 2.25 | 0.001 |
| 5.00 | 0.0010 | | | | | | 2.25 | 0.001 |
| 5.50 | 0.0010 | | | | | | 3.00 | 0.001 |
| 6.00 | 0.0010 | | | | | | 3.00 | 0.001 |
| 7.00 | 0.0020 | 0.0025 | | | | | 4.75 | 0.001 |
| 7.75 | 0.0020 | 0.0025 | | | | | 4.75 | 0.001 |
| 8.50 | 0.0020 | 0.0030 | 0.0025 | | | | 4.75 | 0.001 |
| 9.00 | 0.0020 | 0.0030 | 0.0025 | | | | 4.75 | 0.001 |
| 9.50 | 0.0020 | 0.0040 | 0.0030 | 0.0025 | | | 4.75 | 0.001 |
| 10.25 | 0.0020 | 0.0040 | 0.0030 | 0.0025 | | | 6.00 | 0.001 |
| 11.00 | 0.0025 | 0.0060 | 0.0040 | 0.0030 | | | 6.00 | 0.001 |
| 12.50 | 0.0030 | 0.0080 | 0.0050 | 0.0040 | | | 6.00 | 0.001 |
| 13.75 | 0.0040 | 0.0080 | 0.0060 | 0.0050 | | | 6.00 | 0.0025 |
| 14.50 | 0.0050 | 0.0100 | 0.0070 | 0.0060 | | | 6.00 | 0.0025 |
| 15.75 | 0.0050 | 0.0100 | 0.0080 | 0.0065 | 0.0060 | | 6.75 | 0.0025 |
| 16.50 | 0.0050 | 0.0120 | 0.0080 | 0.0065 | 0.0060 | | 6.75 | 0.0025 |
| 17.25 | 0.0050 | 0.0200 | 0.0140 | 0.0095 | 0.0060 | | 6.75 | 0.0025 |
| 18.50 | 0.0060 | 0.0200 | 0.0140 | 0.0095 | 0.0070 | | 6.75 | 0.0025 |
| 19.00 | 0.0060 | 0.0300 | 0.0175 | 0.0120 | 0.0085 | 0.0070 | 7.75 | 0.0025 |
| 19.75 | 0.0060 | 0.0300 | 0.0175 | 0.0120 | 0.0090 | 0.0070 | 7.75 | 0.0025 |

Turn pistons to dimension *C* minus allowances as per schedule.
Pistons to be relieved on sides by throwing them out of center on a special turning or grinding fixture.
In estimating "play" of pistons in bore do not fail to consider cylinder taper.

half to one and a half or two thousandths of an inch taper in the bore, depending on the size and the length of the cylinder. This will be found to be no serious fault; on the contrary, it is usually considered advantageous because the bore will be more nearly parallel when the engine is at working temperature. One manufacturer even goes so far as to scrape the crank ends of all cylinders with a long-handled scraper for a distance inward equal to about three-quarters of the length of the piston, increasing the diameter at the open end by about one-thousandth of an inch. Another builder heats the breech while reaming the bore, thereby making a tapered bore when the cylinder is cold and an approximately parallel one when the cylinder is hot.

Possibly the commonest practice in fitting pistons to cylinders is to turn or grind the pistons a certain schedule allowance less than the cylinder bore and "relieving" them slightly by filing on both sides about the piston pin to insure a bottom bearing of the piston when it receives the thrust of the connecting rod. A less rapid but, it seems to me, better method is to turn the piston one to three thousandths (according to its diameter) larger than desired for a running fit and to put the engine on the test block and run it with the maximum load that it is capable of carrying and at the regular working temperature, with copious lubrication. After a very short run the piston will be heard to "bump," as it is called, and no mechanic will ever mistake this sound for any other than a tight piston knock if he has once heard it. The piston is then removed and the high spots filed off. This process is repeated a number of times until the piston runs free, all "bump" having disappeared even when a full rush of cold water is turned on suddenly after the engine has operated for some time with a cylinder almost too hot for the hand to bear.

Great care and considerable skill are required to do this kind of fitting but if it is properly done a fine job is the result. There is really no occasion for anyone to "freeze" a piston in fitting it this way if he is careful and if the piston is turned to the proper size beforehand. The piston must be "relieved" very slightly on the sides about the piston-pin holes.

In fitting a piston in the manner just described the engine should be run on the fuel with which it is to be used in service because different fuels, producing different cylinder temperatures, will create different expansions. For example, the piston of a natural-gas engine needs greater allowance than that of a producer-gas engine and the piston of a gasolene engine may need a greater allowance than that of a city-gas engine. Engines to be run with gravity circulation of the cooling water should be especially free-running when hot, because they are liable to be run very hot for long periods where tanks are small, as is usually the case.

It is often the practice by mechanics to allow from a sixteenth to a sixty-fourth of an inch of clearance between the ends of piston rings when fitting them to the cylinder. This is unnecessary and only adds to the leakage. The rings will develop end clearance soon enough and I have found that there has never been the slightest trouble when rings are fitted so that they enter without any clearance at the joints.

Table 1 gives a list of cylinder tapers and directions for taking measurements for the piston diameter as practised by one European builder; Fig. 1 illustrates the instructions and Table 2 gives the schedule of allowances to be made in turning the piston. Fig. 2 is the reference diagram for Table 2. Fig. 3 and Table 3 present the practice of a well known American builder who anneals the pistons before finishing but never files them. For the repairman I would advise using Table 3 with the exception that it will be best to diminish the allowance in column *B* by one to three thousandths, according to size, leaving that amount for filing when the engine is started. Where the piston is very short it would be better also to diminish allowance *A*, as sometimes it is desirable to use the bearing between the rings under such conditions. For pistons two diameters long and over, it is advisable to follow Table 3 entirely. In every case, a piston which has not been annealed before finishing should be filed on the test stand as unexpected irregularities are developed when the casting is heated.

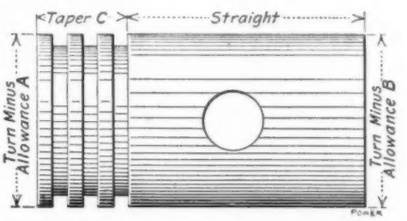



FIG. 3. REFERENCE DIAGRAM FOR TABLE 3

TABLE 3. PISTON TURNING SCHEDULE

NO FILE FITTING ON THESE PISTONS.

| Bore. | A | B | C |
|---|---|---|---|
| 6 | 0.012 | 0.004 | 2¾ |
| 7 | 0.016 | 0.005 | 2¾ |
| 8 | 0.016 | 0.006 | 3¼ |
| 9 | 0.020 | 0.007 | 3½ |
| 10½ | 0.025 | 0.008 | 4½ |
| 11 | 0.025 | 0.008 | 4 5/16 |
| 13 | 0.030 | 0.010 | 5 1/16 |
| 14 | 0.035 | 0.011 | 5½ |
| 15 | 0.040 | 0.012 | 5 13/16 |
| 16 | 0.045 | 0.012 | 6¼ |
| 18 | 0.050 | 0.014 | 7 |
| 19 | 0.050 | 0.015 | 7½ |
| 25 | 0.060 | 0.020 | 9¾ |

NOTE—The 25-inch piston is water cooled. In measuring cylinders mean diameter is taken as the base. No cylinder taper is provided for except that which follows from wear of tool. Cylinders not reamed. Lands do not bear when heated. Pistons 1½ diameters long.

No attempt should be made in a repair shop to taper cylinders by a greater amount than that which is accidentally due to the wear of the boring tool, as special tools are required for this work and in most cases good results can be obtained without much taper. One repair man decided hastily that setting over the tailstock while boring with a bar between the centers of the lathe, the work being mounted on the carriage, would give a tapered bore. The result was an elliptical bore, of course.

Those makers who follow the practice of filing pistons are almost all builders of horizontal single-acting engines.

This article should not be considered as applying to automobile engines; the cylinders of such engines are so short that they are bored straight, with no allowances of the kind described.

## Make and Break Ignition Troubles

BY S. KIRLIN

Trouble is frequently experienced with gas engines having the make-and-break system of ignition due to the contact points becoming corroded or worn down to such a degree that missing fire is frequent enough to cause irregular speed or even a complete shutdown of the engine. When missing is due to the contact points being worn down or corroded it can be quickly proved in the following manner without removing the igniter from the cylinder:

If the engine is small enough to be easily turned by hand, close the switch and hold the blade of a screwdriver or any other iron instrument near the end of the iron core of the spark coil while an assistant turns the engine. If the contact points in the cylinder are in good shape the iron instrument will be jerked to the iron core of the coil by the magnetism each time the engine is turned past the point where the ignition circuit is closed. If the screwdriver is not attracted to the core and if the wiring is in proper condition, it indicates that the trouble is due to the igniter contacts failing to come together, due to their being worn off too much or corroded to such an extent that the battery current cannot pass through them.

Trouble is also caused sometimes by the contact points remaining together due to the pin binding where it passes through the igniter body. This can be detected also by turning the engine over while holding an iron instrument near the coil core and noting whether or not it is jerked to the core each time the ignition point is passed. If it is occasionally held against the core during two revolutions of the engine, it shows that the ignition points are sticking together and failing to make the spark.

# Readers with Something to Say

*Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted*

## Trip Cutoff Kinks

The prevailing practice on engines handling the releasing-gear type of engine is to set the governor rods so that when starting up, both valves will be released at about the same time.

This method is incorrect, although I have seen engineers change the cutoff after the mean effective pressure had been equalized on both sides of the piston by means of the indicator.

The correct method of setting the cutoff on this type of engine when no indicator is available is as follows: Prop the governor up to where it stands at normal load and turn the engine over slowly until the crank-end trip lets go. Then measure the distance the crosshead has traveled on the backward stroke and turn the engine in the direction of rotation until the crosshead has traveled an equal distance on the forward stroke. Adjust the head-end trip to let go when in this position.

Cutoff will take place at the same part of the stroke, and, although it may not exactly divide the load, it is about the best we can do for cutoff without using an indicator.

A. H. LANGMAN.

Aurora, Can.

## Trouble with Steam Radiator

In reference to E. L. Morris' trouble with a heater as described in POWER for January 17, I will say that in my opinion there are several causes for this heater not heating up properly. First, the pressure may be too low for the distance this heater is from the boiler; second, the heater may have become air bound; third, the pressure may be unequal and, by closing the valves down on the other two heaters to just a small opening, the trouble may be partially overcome.

I would suggest that a pet cock be placed on the end of the heater opposite to the inlet valve. This would release the air and help the situation, providing all connections are tight and the valve of the heater is open sufficiently wide.

There is but one thing needful to get the heater to warm up and that is circulation. I have had troubles of this sort and I have found most of them to be due to proper circulation failing to take place either from the fact that the heater was air bound or that it did not have sufficient steam pressure.

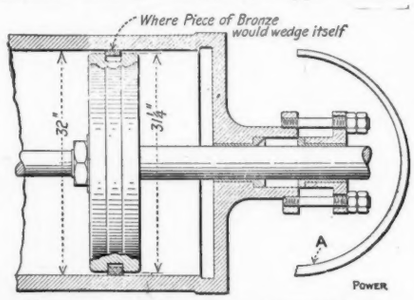
E. F. STRIPPY.

Washington, D. C.

## Bronze Piston Rings

Several years ago, I was employed in a large mill power plant in which there was a large simple steam engine. After the plant had been in operation for some time, the management decided to compound the engine and run condensing, therefore, a new cylinder was ordered from a different firm than had built the engine.

The cylinder and piston dimensions were as shown in the illustration. It will be noted that the cylinder is ¾ inch larger in diameter than the piston. When this cylinder was installed the piston was packed with a well-known type of sectional piston packing, and held out against the cylinder walls by springs.




DESIGN OF PISTON AND PISTON RING

After this packing had been in service for about a year, the engine began to give trouble. To overcome the difficulty the powers that be decided that cast iron was not the thing with which to pack a piston, and that there was but one intelligent method. They decided that a bronze ring of the snap type, cut eccentric, as shown at *A* was the proper ring. Having arrived at this conclusion, the bronze ring was ordered and in due time arrived and was at once put in place.

After very short service the cylinder began to have the time of its life, giving three cheers and a tiger at each revolution.

When the cylinder was opened up, a piece of the thin end of the bronze ring was found wedged between the piston and the cylinder wall. It will be seen that when the piston was centered in the cylinder but ¼ inch of the bronze ring was in the slot in the piston and, as bronze wears away very rapidly when in contact with cast iron, this ¼-inch leverage was very short lived. Consequently, the ring broke about 8 inches from the end and wedged itself as stated.

The "High Grand Mogul" decided "to fight it out along this line if it took all summer," so another bronze ring was put in which shortly proceeded to give a practical demonstration that bronze was bronze and again wedged the thin part of the ring between the cylinder wall and the piston. As there was no idea of giving up our military resolutions, another round of bronze was shot into that cylinder on five occasions, after which the cylinder was again fitted with cast-iron sectional rings.

AMOS S. BACK.

Waterbury, Conn.

## Boiler Inspection Law

Can any reader give a good reason why the legislature of the State of New York has failed to pass a good steam-boiler inspection law or an engineers' license law? True, there is a law in New York State that compels the inspection of locomotive boilers, and the enforcing of this law by the Public Service Commission has compelled the railroad corporations to keep their boilers in good condition.

A similar law should be passed that would make it compulsory to have all boilers used for power purposes examined semi-annually, once internally and once externally, and the boilers to be in charge of competent engineers.

The factory-inspection department sometimes calls for a report on steam boilers, but if it is compulsory to furnish them with a report, the law as enforced is a farce. The owner of a steam boiler can employ any person to make an inspection and send him a report of such inspection to be forwarded to the factory-inspection department, and it is accepted.

I know of many cases where men have made inspections of steam boilers, the reports have been accepted and boilers continued in use, but the men who made the examinations could not figure out the strength of a seam, strength of the braces or stays in the boilers and, in fact, if given all dimensions, they could not figure the steam pressure to be allowed. Certainly such a man could not

be held responsible for any accident occurring after his inspection.

The factory-inspection department accepts the report of an examination made by a steam-boiler insurance company's inspector, but there are hundreds of boilers in the State of New York that are not insured. There are boilers in use that are from 20 to 30 years old, carrying the same steam pressure that was carried when they were first installed. Most of these boilers are of the horizontal return-tubular type, lap-seam construction and carry from 80 to 110 pounds steam pressure; they should be in the scrap heap. Some of these boilers are in charge of men who do not know the risk they are taking in carrying such pressures.

In one of the congested business districts in one of the large cities of the State of New York there is in daily use a battery of two boilers carrying a working pressure of 90 pounds that were practically condemned by an inspector several years ago. The boilers are about 60 inches in diameter by 14 feet long. The shell plates were originally 5/16 inch thick, the longitudinal seams are lap construction, double riveted, and the seam will not figure more than 65 per cent. of the strength of the solid plate. The opening in the shell under the dome is almost the full size of the dome and is not reinforced; the boilers are at least 25 years old. Figure what steam pressure these boilers would safely carry when new, and then imagine what is going to happen at this plant some day. The coroner's jury will, if the usual custom is followed, put the blame on the engineer or fireman, both of whom will doubtless have been killed. There are many plants being operated in worse condition.

There were more than 530 boiler explosions in the United States in 1910, and 280 persons were killed at the time of the explosion; there were also many persons scalded and otherwise injured who later died from the effect of their injuries. There were over 550 boiler explosions in 1909 and about 230 fatalities. The lap-seam boilers carried off the "honors" and, no doubt, the lap-seam engineers, referred to in a recent issue, had charge of the majority of these plants.

There should be a law, rigidly enforced, prohibiting the installation of lap-seam boilers and especially that type made up of two sheets with the longitudinal seams running from head to head. No extra expense is incurred in having the boiler built with butt joints. A triple-riveted joint properly proportioned will give from 84 to 87 per cent. strength of a joint and a quadruple-riveted seam from 92 to 94 per cent. There is no record, as far as known, of a boiler with this type of seam exploding.

R. J. WALTERS.

Rochester, N. Y.

## Laying Pipe under Water

I recently saw a 10-inch wrought-iron pipe laid under water in a very simple manner. The pipe was to be used as an intake for a pump and extended into a shallow lake some 200 feet.

The method adopted was to connect the pipe lengths together, on skids, on the lake shore. A blind flange was put on one end and a foot valve on the other, the foot valve being fastened in a closed position by a wire. Then the pipe was rolled into the water, three men mounted it and with poles punted it into position. Then the foot valve was opened, allowing the whole to sink gradually onto the piers that had been made for it to rest upon.

F. H. STACEY.

Montreal, Can.

## Wood as a Fuel

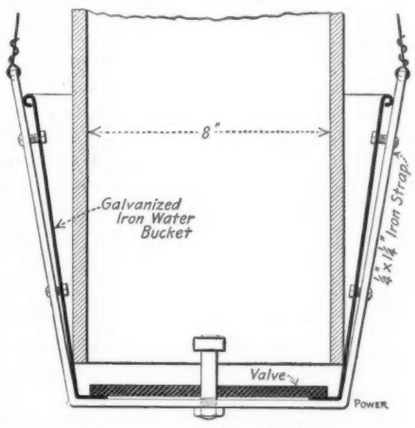
I have two 400-horsepower water-tube boilers under which a mixture of pine and juniper wood is burned. What is the best method of burning such wood as a fuel to obtain the best results?

J. R. BLAKE.

Mogollon, N. M.

## An Emergency Foot Valve

A centrifugal pump persistently refused to pick up its suction water. After all the usual methods of priming, including a siphon, had failed, it was seen that a foot valve would be necessary in order that the pump and suction pipe could be filled with water before starting.




DETAILS OF FOOT VALVE

An ordinary galvanized water bucket was made into a foot valve, as shown in the sketch. A 6-inch hole was cut in its bottom and a valve was made from a piece of heavy rubber belting, cut 1 inch larger than the diameter of the hole in the pail. A ¼x1¼-inch iron strap was bent to fit the bucket, as shown. A ½ inch thread was tapped in this iron strap to receive an ordinary ½-inch bolt to act as a valve stem.

The foot valve was placed over the bottom of the suction pipe and held in place by wires. It was a success.

F. C. HOLLY.

Yazoo City, Miss.

## Overloaded the Engine

In the southern part of Indiana a power plant, supplying power to a large cement factory, experienced considerable difficulty in keeping an exciting set in operation. The plant was of about 1500 kilowatts capacity. Two direct-coupled exciting units had been installed, and the prime movers were twin-cylinder compound steam engines. One unit was of 75 kilowatts capacity, running at 350 revolutions per minute, and the other of 35 kilowatts capacity, at 520 revolutions per minute, which speeds are rather high.

Both exciters gave trouble continually and one or the other of them seemed to be down for repairs all the time. The 75-kilowatt unit was naturally used most, since the exciting load alone was about 35 kilowatts and the entire lighting load of about 20 kilowatts was taken from the exciter busbars also. The 35-kilowatt set was kept pretty busy when the 75-kilowatt set broke down.

For this reason duplicate parts for the larger unit were kept on hand so that the smaller unit need not be operated longer than was absolutely necessary. However, even though the small unit was operated but little, the tremendous overload when it was operated soon began to tell on the engine, and after three or four years this engine also became unreliable, but no duplicate parts were ordered for it.

One day the larger unit began to bump and rattle and, before the steam could be shut off, it had completely wrecked itself, everything within the four cylinders being smashed to bits; the 35-kilowatt unit was then started. Some of the repair parts had to be made, which would require a few weeks, and it looked very much as though there would be trouble before they could arive.

While going over the works the day following the accident, I noticed a band wheel of some sort protruding from a pile of cement and rubbish behind one of the factory buildings, which proved to be a 9x14-inch Atlas side-valve engine that had been used during the building of the factory a few years before. This engine offered the only ray of hope in the solution of the pressing exciter problem, and I decided that it would be able to carry enough of the load to keep the works going nearly full blast day and night.

I knew that these engines were designed for 125 pounds pressure so that perhaps the full boiler pressure of 165 pounds could be withstood if the load demanded such. My greatest fear was that the pressure plate would deflect and bind the valve if a pressure of much over 125 pounds was used.

Timbers were placed in position near the small exciter and the Atlas engine mounted on them in such a way that, should the exciter engine break down, a short shaft could be bolted to the generator shaft by means of a flange coupling and the generator driven by a belt. This arrangement was completed none to soon, for the overloaded exciter engine showed signs of failure a day or two later and had to be stopped.

The shafting was speedily put in place, the belt tightener screwed down and the Atlas engine started on what proved to be a long run. It pounded a great deal and ran hot, and after a half hour's run ordinary lubrication was insufficient so water pipes were arranged to keep streams of water playing on all the bearings. The belt used was of sewed canvas, 8 inches wide.

This outfit ran six weeks, during which time two sets of main bearing parts, three sets of connecting-rod brasses and two belts were used up; crank and wristpins were badly scarred, as were also the main journals. Otherwise the engine as a whole was little harmed. Nothing broke and apparently the cylinder and valve were not touched. The cylinder was lubricated perfectly. The generator was unharmed except that the commutator was slightly burned.

A long shutdown was avoided, contracts were met, and now an exciting set of large size carries the load so easily that one can scarcely realize the supreme effort required by the small 9x14-inch engine to do about 80 horsepower of work.

C. R. MOORE.

Lafayette, Ind.

## Boiler Insurance

A matter connected with boiler insurance recently came to my notice, that is of more than passing interest.

The superintendent of a power plant, after reading a recent discussion relative to boiler insurance, looked up his own policy to see how it was worded. He discovered that his policy allowed him to carry 110 pounds steam pressure on his boilers, but they were carrying 120 pounds. In case of an explosion the policy would probably have been worthless.

On investigation he found that a former superintendent had increased the pressure 10 pounds without consulting the insurance people and, as a consequence, the policy had never been changed.

This condition had existed fully a year and the insurance-company inspectors had inspected the boilers several times since the change had been made, and presumably had noted the pressure carried. They had not, however, reported the matter to the officials of the power-plant company.

Is it possible that the inspectors had passed in their report without the increased pressure being mentioned, had the increased pressure not been detected or had the insurance company wilfully failed to notify the company, knowing that they could not be held in case of an explosion? It would also be of interest to know if under the above circumstances any insurance could have been collected. The boilers were in first-class condition, designed for 150 pounds steam pressure per square inch, and the insurance people readily changed the policy when their attention was called to the increased pressure carried.

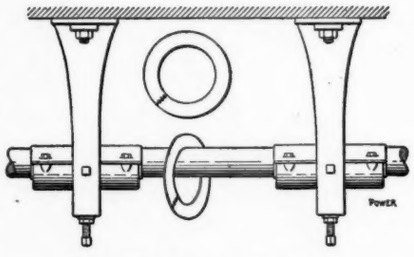
B. JAMSON.

Chicago, Ill.

## Ring Shaft Cleaner

My little kink, while old, may be of use to some engineer who is obliged to keep his line shafting clean and free from dust and oil.

Make several large rings out of belting, leatherboard or some such substance, having a hole about twice the diameter of the shaft, and the outside diameter about 2 inches larger than the inside diameter.



RING CLEANER ON SHAFT

The ring is cut diagonal on one side, put on the shaft, after which the ends are sewed together with fine wire. The ring will travel from one hanger to the other so long as the shaft revolves.

Thus, the shaft will be kept free of dirt and it will eventually take on a bright polish.

H. A. GREENE.

Boston, Mass.

## Flushing Pump Valves

Trouble is often experienced with foreign matter getting under the valves of feed pumps.

It is a simple matter to place a barrel at some elevated place, connect it with the suction pipe of the pump and provide a pipe and valve to the discharge line for filling purposes.

When the pump valves hang up, close the valve in the suction line and open the valve in the pipe leading from the barrel which is kept filled with water. This flushes the pump and saves a lot of trouble, time and temper.

FRANK GARTMANN.

Sheboygan, Wis.

## Unsafe Pulleys

Some days ago, I visited a small sawmill and, while looking over the plant, the manager pointed to a pile of cast iron that had once been a pulley 7 feet in diameter. He said it had burst a few days before and killed the sawyer. I did a little figuring and found that the rim speed of the pulley had been 9560 feet per minute.

To my surprise the new pulley was a duplicate of the one that had exploded and was running at the same speed.

I told him that the high rim speed at which the new pulley was running was liable to burst it, but he said the salesman who sold it said that the old pulley had burst on account of a flaw and that he supposed the one he was now running was perfectly safe. I do not know whether he has killed another sawyer yet or not.

H. T. FRYANT.

Jackson, Miss.

## Adjustment of Crank Pin Brasses

While talking with the superintendent of the company where I am employed a few days ago, our conversation turned to bearings, and I remarked that the crank was running cool, although the brasses were only 0.004 of an inch slack.

"How do you know that?" he inquired.

"Well," I answered, "the wedge tapers ⅛ inch to each inch in length, and the adjusting bolt has eight threads to the inch; therefore, each turn of the bolt will move the brasses 1/64 inch or practically 0.016 inch, so that 1/16 turn of the adjusting bolt will equal a movement of 0.001 inch of the brasses. As the wedge was drawn up so that the brasses were snug against the pin and then slacked back ¼ turn on the bolt, there is not far from 0.004 inch clearance between the pin and the brasses."

ROY W. LYMAN.

Ware, Mass.

## Return System

I would be glad to get some information on the following: The drips from the steam main, separators, reheating coils and four engines are collected in a manifold located in the basement. This manifold is 20 feet below the water line in the boiler. The steam pressure in the boiler is 160 pounds. The difference in pressure between the boiler and the manifold is 10.5 pounds.

Is it possible and practicable to return the condensation to the boiler by means of the Holly system? If so, to what hight will it be necessary to carry the return riser? Also, what should the size of the riser be?

At present I am using steam traps, but they do not give satisfaction.

WILLIAM BOPP.

Washington, D. C.

# Questions Before the House

*Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues*

## Water Hammer and Other Phenomena

In reply to J. W. Payler's inquiries in the March 7 issue under the heading, "Topics for Discussion" the following are my opinions on the topics which he presents:

There appears to be a marked difference between water hammer and the contraction and expansion of a steam line when steam is turned on. When steam is turned into a line of piping slowly, the steam coming in contact with the cold pipe is condensed. The condensation collects on the bottom of the pipe. The incoming steam eventually heats the pipe to a temperature practically the same as its own, but during the first part of the process the water lying along the bottom of the pipe causes unequal expansion to take place, the condensed water acting as a heat insulator.

I would account for the origin of water hammer in the following way: First, there must be a collection of water in a pocket or at some point in the line. Under normal conditions the steam passes over this water. But, when suddenly a demand for more steam arises, the steam picks up the water in passing. The water then attains the same velocity as the steam and when the water strikes a turn or other point where change in direction is necessary, the result is water hammer.

Steam entering a pipe pushes whatever air the pipe may contain along until the air is compressed to the same pressure as that of the entering steam. Very little or no interchange of heat takes place between the steam and air. This is illustrated when air becomes trapped in a radiator; until the air is removed the radiator remains cold almost indefinitely.

The water next to the plates or tubes in a boiler is turned into vapor bubbles. The vapor being lighter than the water rushes to the surface. It is this rising of the vapor that causes the agitation of the water. It will be seen, therefore, that steam is generated at the heating surface.

To demonstrate how a large body of water contained in a boiler is turned into steam when a rupture takes place, the following example is submitted. Assume a boiler in which the steam pressure is 160 pounds gage to contain 20,000 pounds of water. The temperature due to the pressure is 371 degrees. The water in the boiler contains, then, about 3,180,000 B.t.u. above 212 degrees. The latent heat of steam at atmospheric pressure is 970.4 B.t.u. Then the sudden reduction in pressure resulting from the rupture of the boiler would cause the instantaneous evaporation of about

$$\frac{3{,}180{,}000}{970.4} = 3280 \textit{ pounds of water}$$

H. PREW.

Montreal, Quebec.

## Binding "Power"

In the March 7 issue there is an article on filing data after they have been cut from the magazine. This method of preserving data is theoretically perfect, but for practical purposes it seems to me that it could be improved upon. It embraces the necessity of alphabetical indexing, which is a study in itself, and also the problem of what to save.

In a magazine of the scope of POWER the matter of the index is in the hands of a specialist. My substitute for filing away individual articles is a scheme for binding the magazines exclusive of their advertisements. It was suggested to me by my boss, C. E. Patch, chief of the estimating division of the hull department of the Boston navy yard.

I cut a narrow board to the length of the magazine and mark it for holes. The holes are then drilled from the marked side. Then, several magazines are held between this board and a plain unmarked board by a clamp, in the manner shown in Fig. 1. Next, the holes are drilled with a breast drill of 7/64 inch diameter. The holes are made about ½ inch from the back of the magazine. When the holes are drilled, all the leaves of one volume are sewed together with ordinary wrapping twine and a sailors' needle. For covers several leaves from the advertising section are sewed on in front and at the back and the whole covered by a paper or cloth covering. By the use of mucilage between the several leaves, front and back, the effect of a flexible cover is secured. The outside covering of cloth or paper hides the stitches and gives a finished appearance. The cost of the whole is only a few minutes in time and a few cents in money. The only expense is for the outside covering. By treating the magazines in this way a handy record is kept, not only of what you thought you might want to use, but also a vast amount of matter which you just glanced at, never thinking you would need it until the occasion suddenly arose.

J. F. WENTWORTH.

Quincy, Mass.

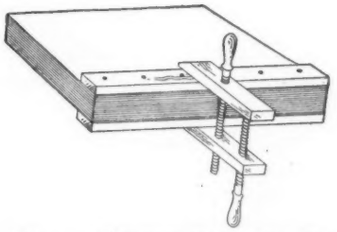


FIG. 1. VOLUME CLAMPED FOR DRILLING HOLES

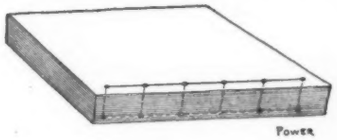



FIG. 2. VOLUME READY FOR COVER

I have noticed several men's ideas for preserving back numbers or interesting articles. I think that it is a poor policy to attempt to outdo the publishers in the matter of indexing—time is too valuable—a particularly useful article can be referred to in a card index or checked in the regular index. The idea of preserving only what seems at the present time to be the useful parts of each issue is a poor one, for one can never tell what will come next, providing he is in a live part of the world and what today is a waste of time to read may be of paramount value tomorrow or next year.

I do not make a practice of reading everything in each issue, but I note all articles which are apt to be of value till such time as I can get the issues bound with the complete index. Thus, when any question arises I have a very useful library at my disposal which is broader in scope on any subject covered than

most of the engineering books published. The cost of binding is usually from $1.50 per volume, up.

C. W. BELL.

Taylor, Penn.

## Stress in Boiler Sheets

Regarding the editorial under the above heading in the February 28 issue, it seems to me that a confusion has been made about the line of least resistance. However, the question brought up will make a large number of readers do some thinking, and for that reason it will be valuable.

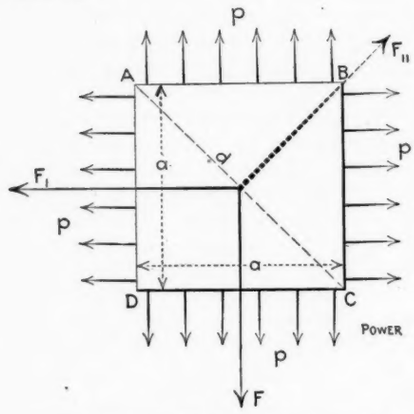



DIAGRAM FOR SPECIFIC SOLUTION

In the first place, the fact should be noted that when testing cylinderical shells by bursting them, the rupture invariably takes place lengthwise of the cylinder. The reason for the split being lengthwise and not either circumferentially or slantwise is because the least resistance is along this line, least resistance because there is the least material to withstand the stress. Thus, the stress per unit length on the line *A* of Fig. 1 is $\frac{PD}{2}$

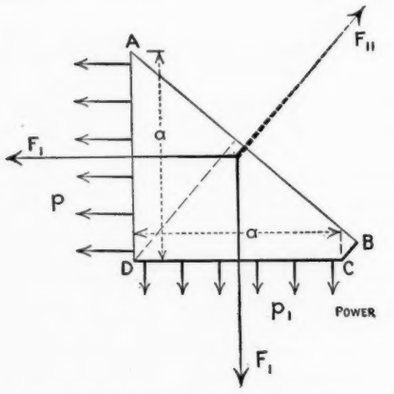



DIAGRAM FOR GENERAL SOLUTION

and the material to withstand this stress is *T*. At right angles to the stress on the line *A* of Fig 1. the stress tending to tear the plate along the line *B* of Fig. 2 is $\frac{P\pi D^2}{4}$, and the material to withstand it is $\pi D T$. As, based on the thickness alone, the stress in Fig. 2 is

$$\frac{P\pi D^2}{4} \div \pi D = \frac{PD}{4}$$

being half as much as in Fig. 1; on the other basis, there is twice as much material to withstand the stress in Fig. 2 as there is in Fig. 1; hence, the section in Fig. 2 is stronger and less liable to split. It follows then, that at any other locations, *C* and *E*, Fig. 3, between these two lines *A* and *B* of minimum and maximum strength, the strength will be less than at *B* and greater than at *A*.

It can be shown by an elaborate mathematical demonstration how that two stresses, one half the other, acting at right angles, will give a resultant diagonal *H*, Fig. 4; and, further, how some of this stress *K* is lengthwise of *H* and some *L* at right angles to it. The action of *K* is to shear the plate into two triangles *M* and *N*, while that of *L* is to tear them apart. This mathematical treatise will give any engineer good mental exercise. It will lead him, though, providing he does not get lost in the thicket of figures and symbols, to the same station

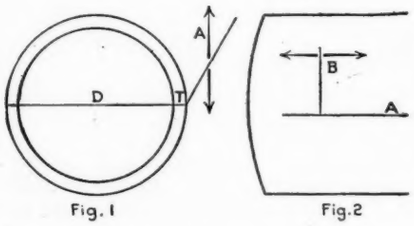



Fig. 1




Fig. 2

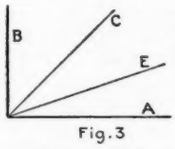



Fig. 3

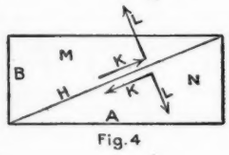



Fig. 4

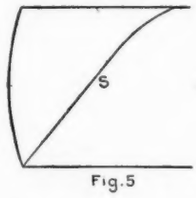



Fig. 5

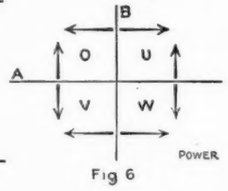



Fig 6

that the experimental facts have long since located. Rupture does not take place along the helical seam *S*, Fig. 5, nor does the plate separate into four rectangles *O, U, V, W*, Fig. 6.

F. WEBSTER.

Scranton, Penn.

## Blowoff Pipe Protection

I noticed in the issue of March 21 an account of the bursting of a cast-iron elbow in the blowoff of a 135-horsepower boiler. No cause was given for the failure of the elbow.

I was once called to take charge of a steam plant in which the blowoff pipe of the boiler was screwed into the front head of the boiler alongside of the handhole and a hole was drilled in the boiler front, through which the pipe passed just far enough to screw on a valve, short nipple and an elbow. The blowoff then passed through the wall of the boiler house and connected with a blowoff tank in the yard. The boiler-house wall was used for the side wall of the boiler setting. Where the blowoff went through the wall it was bricked in solid. I consider this very unsafe as I contend that all blowoff pipes should be left free so as not to be affected by expansion or by any settling that may take place.

EDWARD HAMILTON.

Ridgefield Park, N. J.

## Slipping Latch Blocks

In POWER for February 28 and March 28 are letters on the subject of "Slipping Latch Blocks," giving useful instructions as to what to do to prevent or overcome trouble from this source.

The design of the valve gear has a great deal to do with the amount of this trouble and in selecting an engine care should be taken to select a design of gear that will give the least trouble.

We had an engine that gave us a great deal of trouble in this respect, the latch blocks having to be turned once in two or three weeks. After running for several years the gear became so badly worn that it was replaced with a gear of different design. Since that time we have had to change the blocks only about once a year. The difference is not in the blocks, for we tried several different steels with the old gear and made the blocks as hard as it was possible to make them, but even the hardest would slip in a short time.

W. O. PERKINS.

Bristol, Conn.

## Central Station versus Isolated Plant

The editorials in the issue of March 28 entitled, "Will an Isolated Plant Pay" and "The Marginal Principle," strike the nail squarely on the head and put the matter in the plainest possible way. I wish they could be read by every power user. The fanciful and exaggerated charges saddled upon the steam plant when the central-station man is swelling his list to show the awful waste only go to show his desperation in working for business that he sees slipping from him. Could this be any better illustrated than in Mr. Parker's paper on "The Cost of Industrial Power," reported in POWER for March 21? Conceive, if you can, a plant of 150 kilowatts capacity with a $12,000 manager, devoting one-twelfth of his entire time to the power equipment! And, this not being enough, the cost is still further padded to the extent of $150 per year for one hour daily clerical work. This generosity is not shown in the purchased-power table, where the wear and tear on the manager

and clerks, due to the heating plant, is fixed at $25 per year, surely low enough in comparison.

Again, in this paper the "emergency service" is given at $936 per year. This is based on four days' shutdown per month. Does anyone know of a power plant, working under ordinary conditions, that is shut down on an average of four working days per month? If so, will the engineer please stand up and, if it is not a worn-out, obsolete plant, tell us how long he expects to hold his job? A charge for emergency service is, of course, proper if, as is usually the case, the power user wishes to retain the central-station connections for such use, but there is a lack of fairness in placing it at an extravagant cost, merely to make the right kind of a showing. If this cost were correct, emergency current would be a highly profitable part of the central station's business, inasmuch as it is at a rate nearly three times the amount per kilowatt-hour of the regularly furnished current in the other table, which figures out 2.47 cents. It would be equitable to credit back the coal that is not used during the 48 days per year that the plant is supposed to be out of business, but no such credit appears.

It appears that in the isolated plant 300 horsepower is installed for a demand load of 140 kilowatts, fully 25 per cent. more than necessary, but this makes the estimate item of supplies and repairs higher, and all goes to swell the total cost.

It is to be regretted that comparisons of this kind, figured out by central-station representatives, can only be made with a view of obtaining patronage, for it would certainly seem that they are not made with a desire to arrive at true and correct results. There is plenty of business for the central stations in public lighting, railways, etc., as well as in many isolated plants where exhaust steam has little or no value, especially in small units where the labor item is a very large percentage of the whole. But, no amount of argument can prove that purchased power is cheaper than that furnished by the isolated plant in the majority of cases where use can be made of all or a considerable portion of the exhaust steam, which is a most valuable byproduct. This means with every legitimate item of cost figured in, but not the "amortization" of the manager and his clerks, unless we also estimate, on the other hand, how much his monthly quarrel with the central station over the current bills shortens his life. Nor will we include a charge for the amount of money the cost of the power plant *might* have earned if he played the stock market and struck it right, which is just as consistent as the item of "profit rates."

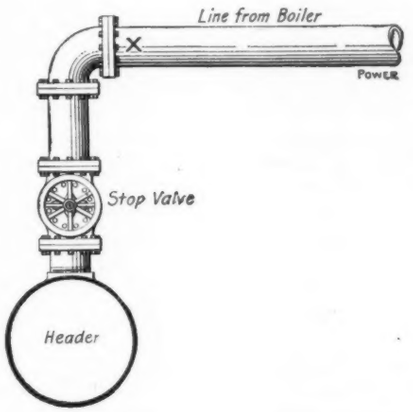
In the city of Buffalo, within 20 miles of the much touted Niagara Falls power, steam plants are in use by the hundreds and new ones going in constantly, where careful investigations have shown the lower cost for power in the isolated plant. And, in this connection, it may not be generally known that at least one power-equipment company is installing steam plants in whole or in part, and taking its pay in the saving made over the cost of purchased power. I know of several plants that have been purchased in this way, and all are making good. One of these is a $20,000 plant that paid for itself inside of two years. When an engineering company is willing to take business on these terms, we can hardly wonder that the central-station companies work up the kind of papers that are read before engineering societies, biased as these papers are in favor of purchased power.

W. J. CREELMAN.

Rochester, N. Y.

## Position of Stop Valves

The March 14 issue contains a description of the new power plant of the Amoskeag mills, an institution, I believe, well known among engineers in all parts of the country for its uptodate management and power-plant equipment.




PRESENT AND PROPOSED POSITIONS OF VALVE

I may have been asleep while some new things in steam piping were being promulgated, but, never having been shown differently, I must still hold the opinion that the proper place for a stop valve would be in the horizontal pipe, as at *X*, instead of in the vertical connection. With the valve at point *X* the possibility of a slug of water lying above the valve and the necessity of a drain pipe above the valve are eliminated. But, as it is inconceivable that an institution of such reputation should make such an installation without every detail being "exactly right," there must be some very good reasons why the stop valves were placed in their present positions. I would like very much to be enlightened.

F. C. HOLLY.

Yazoo City, Miss.

## The Benefit of Organization

I have read Mr. Gotstein's letter in the March 14 issue and would say that what he has said with reference to engineers' wages is a fact that we cannot get away from. The solution does not rest upon forming an organization with a resolve to stick together, but rather on the basis that an organization be formed with a view to raising the individual standard along educational lines in order to be able to present the matter to the owners of plants in such a way that they cannot refuse an increased wage when it is requested.

We have at the present time any number of engineers' organizations but each has its own ideas of doing things.

I venture to say that it would be far better and more beneficial to all concerned if they would all come together under one name and for one purpose, and that purpose to be the uplifting of the men who are running the very heart of the great industries of today. After all said and done, what would an office building, factory, mill, hospital or apartment house be without a competent man to operate intelligently the machinery that is necessary to run its elevators, supply its light, water, etc.?

The time is now ripe for the men in this most important branch of industry to look around them and wake up to the fact that something is slipping away from them, get busy and start a movement that will make it necessary for the central-station solicitors do some mighty hard work before they can earn their salaries.

H. H. BURLEY.

Brooklyn, N. Y.

## Reduced Grate Area at Light Loads

I have just read the editorial, "Reduced Grate Area at Light Loads," which appeared in the issue of March 21, and feel moved to write of a recent experience of my own along these lines.

Two of my friends, owners of the local steam laundry, sought my advice as to the possibility of reducing the coal consumption in their plant.

On visiting the plant I found a 50-horsepower return-tubular boiler, very much underloaded, the engineer's chief difficulty being to prevent the safety valve from popping. This was accomplished by a damper in the stack and by the occasional opening of the firing door.

I had the grate surface reduced by bricking off 8½ inches on each side of the firebox and as a result the coal consumption was reduced from four and a half to three tons per week.

This is perhaps an extreme case but it illustrates a possibility which is often overlooked.

LINDSAY DUNCAN.

McGill, Nev.

## Interest and Sinking Fund

In the issue of March 21 in an editorial under the above caption a line of reasoning is followed from which I venture to dissent.

Referring to the discussion of the subject, "The Cost of Industrial Power," which took place at the recent joint meeting of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, the editorial contains the statement that "one of the central-station solicitors maintained that it was not right to reduce the sinking-fund charges because inquiry upon his part had revealed the fact that nobody invested the money thus charged annually to the plant at compound interest," and the writer of the editorial then proceeded to show why, in his opinion, a sinking-fund charge based upon compound interest is justifiable.

The accumulation of a sinking fund with the assistance of the accretions due to compound interest appears attractive upon its face, but it is not in accordance with established methods of finance. The fiscal considerations which are involved in present-day commercial activities are confined—so far as the profit and loss account is concerned—to the limits of a single year or, in some cases, to a period of even shorter duration. If this were not so, or if the compound-interest theory were applied—as it logically could be—to all expenditures, a decidedly involved condition of affairs would result. For example, suppose that a man should view his personal expenditures from the compound-interest point of view and, instead of striking a yearly or monthly balance between his income and his expenses, he should look upon the expenditure required for a cigar or for a drink, not as the sum directly involved, but as the amount which the expenditure would amount to at compound interest at the end of a certain number of years. A few calculations of this nature would doubtless cure many of the smoking habit, and would tend to make the "water wagon" more attractive to many than it is at present.

There is another point of view from which, in the writer's opinion, the compound-interest theory is untenable. If we consider that the natural function of money—or capital—is to bring a yearly return to its owner, and that when it is not so doing a direct loss results to its possessor, equal in amount to the interest which could have been obtained (not necessarily the highest rate of return which could have been obtained, but a fair average rate), it is evident that the accretions to a sinking fund in the form of interest are as much of a burden upon the person who is accumulating the fund as contributions of equal amount paid directly into the fund. In the one case a direct payment of, say, a comparatively small amount is made yearly to the fund and the interest for the preceding year upon the accumulated portion of the fund is added. This interest, therefore, cannot be withdrawn (inasmuch as "one cannot eat his cake and have it too") and, in this sense, it is lost to the owner of the fund, thereby making the final result no different than if the owner had withdrawn his yearly interest (a normal condition, the reverse of which only signifies a loss) and then paid an equal amount directly into the fund. On the other hand, under straight-line depreciation, with equal and larger amounts paid yearly into the sinking fund, the owner may withdraw his yearly interest and the equal yearly amounts paid into the fund become his only burden. In either case, the final result is the same: at the termination of the estimated life of the equipment the owner will have paid (in one case partly in the form of lost interest) an amount equal to the original value of the equipment.

E. F. Tweedy.

New York City.

## Feed Water Treatment

In regard to Mr. Utz's letter in the January 31 issue and Charles H. Taylor's well grounded letter in Power for December 6, 1910, relative to feeding solvents to steam boilers, the opinions contained therein certainly make an interesting contrast. Each of them, from the standpoint of a practical critic, if it be possile to assume such a rôle, deviates considerably from the straight and narrow path which practical experimenting has blazoned through the dense forest of obstacles confronting users of "solvents," or "boiler solvents." In a great many cases the latter term is not a misnomer, for certainly the most significant point in Mr. Utz's argument is that he has been using a "boiler solvent" instead of a treatment to neutralize the troublesome elements carried in his boiler-feed water. Most certainly if the solvent he is using scores the pump lining and rods and destroys the packing, it will continue its havoc through the entire feed-water system and, consequently, in the boiler where pitting and corrosion must naturally result; and this, if continued, is not only a financial loss, but tends to intensify the dangers naturally prevalent in steam-generating sets.

It has been my experience that in order to use a treatment for boiler-feed water, it is necessary first to ascertain the mineral contents of the water used. Not having the apparatus for this purpose, we have always sent a representative sample of the water to a well known Chicago firm which makes this matter a specialty. It then selects from one of its numerous formulas (if necessary, it will specially prepare one) a compound that will neutralize the salts, etc., carried in the water. I have used one of its formulas for a number of years, introducing the compound into the boilers by placing a solution of it in a tank placed above the discharge section of the hotwell and allowing it to drop continuously into a ½-inch pipe leading down and looking into the feed-pump suction. In this way the compound is thoroughly mixed with the water and passes through the pump. We have never experienced the least ill effect from the use of this compound, which has always been fed through the feed pumps.

A. Lee.

Honolulu, T. H.

## Dashpot Troubles

Referring to Mr. Green's article under the above caption in the March 21 issue, I have found that the greatest trouble, as Mr. Green has mentioned, is given by Corliss valves of the multiported type equipped with the combination vacuum cushion dashpots. After they become slightly worn the trouble begins and is manifested mostly by the engine racing when suddenly it loses the load. The indicator diagrams show a constant reaching of the governor or a hunting for the point of equilibrium and the average engineer looks for a slipping governor belt and a poorly working gagpot as the cause, without suspecting the real trouble. Most of these double-ported valves have very little or no lap and require careful adjustment else they will admit steam at the back edge when they are supposed to be closed.

There are many kinds of dashpots, and each has advantages and disadvantages peculiar to its type and the engines upon which it is used. The vacuum-cushion dashpot used on some types of engine consists of a central vacuum chamber surrounding the piston or plunger, in which are the valves of the cushion chamber. The cylinder of the vacuum chamber is in the center of the cushion piston and is, therefore, hard to keep lubricated. The outlet-air valve of the vacuum chamber is on the upper end of the cylinder above the cushion piston.

The following is a case from my experience. For some reason the dashpot would bounce and continue to bounce as the engine increased in speed. After placing my foot on the dashpot and forcing it shut with my weight, I removed the cover and put engine oil on the air valve of the vacuum chamber. There was a sharp hiss as the air passed through this valve, and the dashpot operated normally for about two hours. Then the treatment had to be repeated. At the end of the day's run I removed the gummed oil and dirt from the small holes in this valve seat and found that the seat and valve disk were worn enough to admit air to the vacuum chamber which was so dry that it also drew air in from

the cushion chamber past the piston, thus forming a cushion in the vacuum chamber. As a result of the 1/16-inch holes being almost entirely stopped up, there was not enough opening through which this larger volume of air could escape. Adding this cushion to that of the cushion chamber it required but little to make the piston bounce. Placing some quartz under the disk on the seat and putting a bit-brace screwdriver into a breast drill, I ground the valve in and smoothed the roughness off with pumice stone until the valve was air tight. I then cleaned out the four 1/16-inch holes, and smearing the vacuum plunger with oil, reassembled the dashpot, and it gave no further trouble except when the vacuum plunger ceased to get the oil at the bottom to keep it air tight.

Mr. Green spoke of connecting the vacuum chamber to the condenser. This would insure a more perfect vacuum and positive cutoff, but on heavy loads when the dashpots lifted to the full hight it would be apt to cause much pounding on the cushion valves which, if made of leather, would soon give out. Then, too, the greater the vacuum the harder it would be to open the steam valves, thus bringing more load on the eccentric which would be apt to heat.

R. A. CULTRA.

Cambridge, Mass.

## Proper Use of Tools

In a recent issue I came across an article by H. A. Greene showing how to use a pipe wrench without crushing the pipe. He could have added lots more to his article.

It is certainly interesting to hear a steamfitter tell how an engineer should be "fired" for using a monkey wrench as a hammer, while he on one side and his helper on the other of a piece of 2½-inch pipe are yanking and jerking a new cutter (of the one-wheel kind) backward and forward over about one-half the circumference of the pipe, tightening the cutter at each jerk and then forcing it over the remainder of the circumference of the pipe that is not yet cut. After several pipe lengths have been cut in this manner, the engineer finds his new pipe cutter strained or twisted out of shape and really unfit for further use.

While on the subject of tools, a point that I would like to mention is that of wrench handles. Why are they not longer? Considering the way in which the majority of men use a wrench, it seems to me that it is high time for manufacturers to change the lengths of pipe-wrench handles. For instance, the present 18-inch wrench might have its handle lengthened to 36 inches, and the handles of other sizes of wrench might be changed in a like manner. This certainly would save an enormous amount of time for it would be unnecessary to stop to look for a piece of pipe of the right size and length to go over the wrench handle.

Just a few days ago I saw a new 48-inch pipe wrench ruined by a chief engineer (who is usually very particular). He got three heavy men to swing on a piece of pipe 6 feet long on the end of the wrench. Pipe wrenches 48 inches in size cost money.

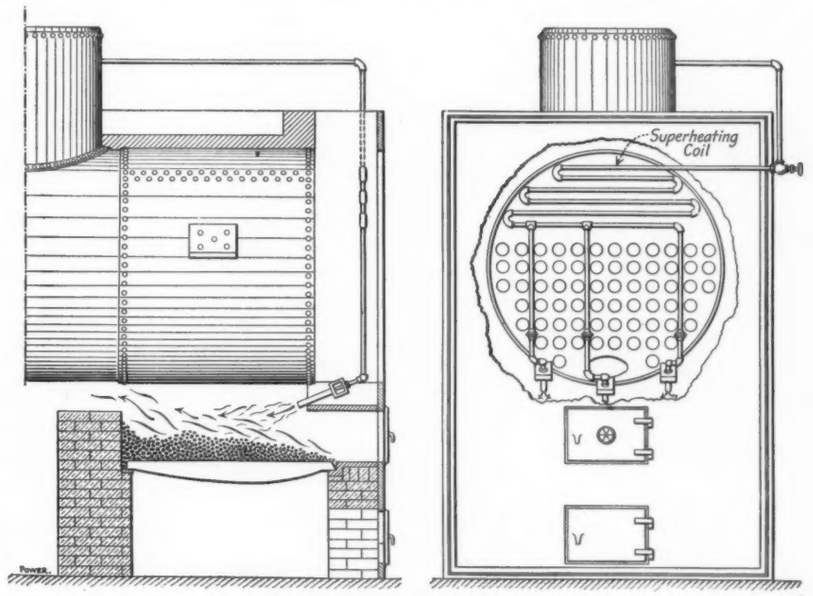
ROMAN S. WILHELM.

Indianapolis, Ind.

## Furnace for Bituminous Coal

Referring to Mr. De Motte's letter in the March 21 issue, I would advise him to install a smoke preventer similar to the one described in the January 10 number. I have one in use and can say that it accomplishes results very satisfactorily.

Of course, to give good results the device must be properly adjusted. In the installation which I made, the pipe from the boiler to the superheating coils is ¾ inch in size. The outlets from the coil to the nozzles are of ½-inch pipe. The castings for the nozzles are 4 inches in size each way and open on two sides, as shown in the figure. One side of each casting was drilled and tapped for a piece of a 1½-inch pipe which was cut long enough to extend over the fire about 2½ inches. Opposite this pipe a ⅜-inch pipe drawn down so as to have a $\frac{3}{16}$-inch opening was screwed into the casting. The tip of the latter pipe comes within ¾ of an inch of the 1½-inch pipe.




THE SMOKE PREVENTER

The boiler under which I use this device is 60 inches in diameter and 16 feet long. With a 72-inch or larger boiler it might be well to use four nozzles instead of three. I find that when the steam-inlet valve is opened only about one-third of a turn, enough steam is admitted to secure good results. A little experimenting will enable Mr. De Motte to decide what the necessary quantity of steam is and to regulate the inlet accordingly.

FRED. SMITH.

Port Clinton, O.

## Effect of Discharge Pipe Size on Motor Load

Referring to Mr. Lee's letter in the March 14 issue, probably the reason why the 3-inch bushing was put in the discharge pipe was to produce a greater velocity in the discharge pipe. A pump having the suction and the discharge pipe equal in size will work successfully only in low-pressure systems.

Mr. Lee should have given both the suction and the discharge head so that a more accurate analysis of his problem could be made.

J. E. STROTHER.

Yuma, Ariz.

## Change of Cutoff

H. Jones has a letter under the above heading in the March 21 number. I think that he is mistaken in the directions which he gives for changing the cutoff on a Brown engine.

The point of cutoff may be changed by changing the boiler pressure, the back pressure, or the load on the engine. The cutoff is controlled by the governor which regulates the volume of steam according to requirements. If the cutoff is uneven between the ends it may be evened by adjusting the taper pin or the nurl screw at the head end.

The question looks to me as though it might have been asked at an engineers' examination to determine whether the applicant fully realized that the governor controls the amount of steam admitted.

LESTER A. FITTS.

West Fitchburg, Mass.

# Questions Before the House

**Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues**

## *Clogged Gage Pipe*

Two recording-pressure gages are connected to the same water main, but they do not record the same pressure. I have been told that the pipe of one is clogged which prevents it from giving the true pressure. How can I find out if this is a fact?

P. C. G.

One of the gages is incorrect and perhaps both are. They should be tested by comparison with a gage known to be correct. No amount of clogging in the gage pipe unless it stopped it entirely would affect the reading unless there is flow through the stricture. The gages must, of course, be at the same hight so that the effect of the columns of water in the pipes leading to them will be equal.

## *Weakest Part of Boiler*

Where is the weakest part of a vertical fire-tube boiler, and why?

W. P. B.

The weakest part of any tubular boiler is the longitudinal seam. It is not possible to make a joint as strong as the sheet and the stress tending to pull the metal apart along its length is only one-half that which is exerted to separate it circumferentially.

## *Cooling Hot Bearings*

I have an engine bearing that frequently goes hot at short notice and without any apparent cause, and I have to stop until the bearing is cool. Is there any preparation that will cool a hot bearing while running?

H. C. B.

Before the days of graphite a mixture of lard oil and flour of sulphur was the standard remedy for hot boxes. Graphite and good lubricating oil in proportions of ten parts of oil to one of graphite will usually reduce the friction of a troublesome bearing until it will run cool.

## *Pitch of Steam Pipe*

Should the steam pipe incline toward the engine or toward the boiler, and why?

P. S. P.

It is better to have the pipe incline toward the engine. Then any water which condenses in it goes along with the steam and is passed off a little at a time. If the inclination is in the other direction, the flowing water is opposed by the current of steam and may accumulate into a large volume which will go over all at once.

## *Low Speed in a Motor*

A shunt-wound variable-speed motor rated at 1350 revolutions per minute, maximum, will not run faster than 1000 revolutions per minute. What is the probable cause, and can the speed be increased by adding to the resistance in the starting box?

E. C.

The voltage may be low or the field section of the speed regulator may be partly short-circuited. The speed can be increased by increasing the resistance in the field section of the controller, not in the starting section, which is in the armature circuit.

## *Net Diameter of Bolts*

How much greater is the diameter at the root of the United States standard thread than in the case of a V or sharp thread of the same pitch?

R. E.

In the standard thread the diameter of the bolt at the bottom of the thread is ¼ the hight of the thread greater than in the case of the V or sharp thread.

The diameter of a bolt at the bottom of the standard thread, in inches, is

$$\text{Dia. of bolt} - \frac{1.299}{\text{Number of threads per inch}}$$

For the sharp thread the diameter is

$$\text{Dia. of bolt} - \frac{1.733}{\text{Number of threads per inch}}$$

## *Indicator Springs for Given Boiler Pressure*

What number of spring should be used in an indicator for 100 pounds boiler pressure?

E. A. S.

For ordinary conditions a spring which will make a diagram 1¾ inches high will be found satisfactory. With 100 pounds boiler pressure a 50 spring will give approximately the desired hight, as the pressure in the cylinder never equals that in the boiler.

## *High Temperatures in Gas Engine Cylinders*

Will it injure a gas-engine cylinder to run it very hot, provided the maximum temperature is not high enough to decompose the lubricating oil?

F. E. W.

Probably not, but the advantages due to high temperatures are not worth the risk of experimenting in that direction. The temperature of the cooling water at the jacket outlet should not be more than 100 degrees (Fahrenheit) higher than the temperature of the entering water.

## *Rotor Current of an Induction Motor*

*a.* What is the usual ratio between the stator and rotor currents of an induction motor?

*b.* What would be the probable rotor current of a 75-horsepower 240-volt three-phase motor?

L. J. G.

*a.* There is no definite relation between the stator and rotor currents. The rotor current depends only on the rotor slip, the field strength and the resistance of the rotor circuit.

*b.* About 180 amperes, regardless of primary voltage and phases.

## *Air Compressor Capacity*

What is the free air capacity of a compressor?

R. E. M.

The cubic feet of free air it can handle per minute, hour or other unit of time. That is equal to the piston displacement in cubic feet multiplied by the number of piston strokes per minute or hour or other period. "Free" air is air at atmospheric pressure and temperature.

## *Three-phase Power Measurement*

Can the power in a three-phase circuit be figured from the switchboard instruments without a wattmeter?

R. E. M.

Yes; if you have a power-factor indicator and the circuit is balanced. Multiply the voltage by the amperes per phase; multiply the product by the power factor and that product by 1.732; the final result will be the watts in the circuit. Example: Volts, 2300; amperes per phase, 50; power factor, 80 per cent. Watts $= 2300 \times 50 \times 0.8 \times 1.732 = 159{,}344$. If the circuit is not balanced, add the currents in the three legs and divide the sum by 3; take the result as the current per phase. This is approximately correct.

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# POWER

## Governmental Control of Water Power

The conservation movement as applied to water powers, and which is now receiving so much attention, may be summed up as follows:

The development of high-tension transmission has made possible the utilization of water powers which, owing to their remote location far from any market for power, have heretofore been unavailable. The promoters, knowing that more or less risk is involved in the development of most water powers, wish to obtain the privileges upon practically their own terms. On the other hand, the people, having more than once been the victims of monopolistic control, have called a halt until they can see their way clear to grant the use of these water powers upon equitable terms.

One fact is agreed upon by all parties concerned; this is that the present laws regarding the point at issue are inadequate, being for the most part cumbersome and involving a division of authority. This is especially true where the rights of several States are jointly involved. In view of this it would seem desirable to centralize the authority and simplify the laws, at the same time making them flexible enough to fit each particular case.

The main point of difference between public opinion and the views of those promoting water-power developments seems to center about two points: First, whether the Government shall be paid for the use of the water; second, whether it shall be limited or unlimited tenure. Regarding the first point, the promoters argue that the public will receive power at cheaper rates if the power company does not have to pay a tax upon the use of the water; furthermore, that due to uncertain conditions of flow, as well as uncertain markets for power, it is often impossible to reap a fair return upon the capital invested; therefore they should not be taxed upon this investment. The former contention will probably be found to have very little effect upon the selling price of power unless the rates are controlled by the people as through a public-service commission, but the latter is well founded. Obviously, it would not be fair for a power company to pay a tax based upon the maximum development of fifty thousand horsepower when six months out of the year they were deriving only twenty thousand horsepower from this source. However, one way out of this difficulty would be to base the tax upon the actual power developed.

As regards limited or unlimited tenure, the power interests claim that it is hard to finance a project involving a limited tenure, and that limited tenure also necessitates an additional amortization charge. It is hard to see why this contention should hold true if proper provisions are made for safeguarding the property at the expiration of the franchise. J. G. White, at the recent conference held under the auspices of the National Electric Light Association remarked that he had yet to learn of a single case in which the right of revocation had been exercised where the business had been carried on in good faith. From the viewpoint of the public, conditions are constantly changing; hence, why should we tie the hands of future generations by granting unlimited tenures?

The recent conference undoubtedly accomplished much toward a better understanding of both sides of the question, although perhaps still more would have been gained had the papers been less general and more specific in character.

## Recording Instruments

"Knowledge is power."

In steam engineering and in other branches of industrial endeavor this truism may be revised to: "Knowledge is more power," in which the term power is used in the literal sense. In the "good old days" this was not so well and widely known as it is now. Even in these improved times it is not as thoroughly understood as might be desired.

Only a few decades ago pig iron was manufactured by the crudest of hit-or-miss methods. The proportions of ore, limestone and coke or charcoal were determined entirely by personal judgment based on the experience of the operator. When an "off cast" or a batch of bad iron was made, which occurred with distressing frequency, the operator would blaspheme his luck and hope for better things.

The condition of the furnace was guessed at; the operator would hold his hand over its top and take a look through a peek hole or two, and by the degree of heat that he felt and light that he saw, would decide that "she" needed another charge, more "wind" or something else, as the case might be.

Competition grew keen. The more progressive iron makers began to study their business in a thorough and scientific manner. Chemists were employed to investigate the chemical phases of the problem of refining iron cheaply and with control over the quality. The influences of the temperature and the air supply in the furnace were determined with exactness.

With the acquisition of exact knowledge came the necessity of and, consequently, the demand for means of accurately measuring the variable factors in furnace operation, such as the blast pressure and temperature, the top-gas temperature and the quantity of the air supply.

It has been alleged that "Necessity is the mother of invention." It proved so to be in the present instance, for closely following the demand came the supply of suitable recording pyrometers, recording pressure gages and engine-speed recorders. By the aid of such equipment, the furnace man can tell at what temperature, in what quantities and under what pressure the air supply is going into the furnace. Further, he can compare today's conditions with those of yesterday or a year ago, for he has the records.

In the power plant education and competition are fast creating conditions similar to these in the iron-refining business. Success demands that accurate and complete knowledge be acquired of what is going on in the boiler and the engine room.

Although this is truest of the operations in the boiler room, progress there has been slowest.

How idiotic it would seem to attempt to operate a boiler today not equipped with a steam-pressure gage and a water column. Yet, there was a time when such was "all the fashion"—in the days of "haystack" boilers. A platform encircled the boiler at a convenient hight and when the fireman wanted to gratify a curiosity as to where the water level stood he would mount said platform and give the boiler sundry kicks amidships which, by the process of elimination, eventually established the point in question. When the steam pressure rose too much the safety valve rectified conditions—when it fell too far, the engine served notice and the fireman did the rest.

It is not improbable that the time will come when it will seem similarly foolish to operate a boiler plant without such things as feed-water meters, automatic fuel weighers, recording draft gages and thermometers, $CO_2$ records, etc.

In many quarters a demand already exists for accurate recording devices. When the manufacturer places on the market instruments that are reasonably low in first cost and upkeep, simple and substantial in construction and accurate and reliable in operation, he will lend a great aid to the right kind of progress in steam engineering. Great possibilities lie in this field.

## Not A Rival

From the public utterances of a number of prominent members of the National Association of Stationary Engineers, it would seem that the Institute of Operating Engineers is regarded as a rival organization, the growth of which is to be discouraged. This is a misconception. The Institute is a school for the systematic education of engineers and machinery operators and is no more a rival of the National Association than any other educational movement. It proposes to do in a thorough and orderly way that which fraternal organizations can only handle in an incomplete and desultory manner.

The fireman and his helper, the oiler, and all other power-plant employees, however ambitious and able, are denied membership in the fraternal organizations of the aristocrats of the vocation, while the doors of the Institute are open to all, and the future standing of any member will depend entirely upon his mental and manual attainments. Instead of being a rival, the Institute will become a source of membership of the highest quality to the fraternal bodies.

## Indexing Engineering Literature

The literature committee of the Institute of Operating Engineers is sending to the members of that society digests of articles in the leading engineering papers. The digests are classified by subjects, three of the articles upon boilers being abstracted as follows:

**BOILERS**

**Boilers and Piping of Wieboldt Building.** Osborn Monnett. Giving some very good ideas on piping layout as to size, showing clearly that a much smaller pipe can be used for the run by placing a good-sized receiver at throttle on engine.
1½ pp. 5 ills. Power, Feb. 7, 1911

**Modern Boiler Plant of Holyoke, Mass.** Warren O. Rogers. Illustrating how a great saving was made by building a central station to do the work formerly done by several plants. Method of coal conveying and handling, damper regulation, feed water measuring, results of boiler tests, etc.
6½ pp. 15 ills. Power, Feb. 14, 1911

**Firing Boiler with Pulverized Coal.** W. S. Worth. Giving the performance of a 300 h. p. boiler fitted with the Blake system of pulverizing for period of 300 days, with full details of how a proper mixture of air is attained.
5 pp. 3 ills. Power, Feb. 14, 1911

The above is a reduction, the original size being such that it may be pasted upon a regular 3x5-inch index card and these cards filed either alphabetically or by subjects as the user may prefer. The persistent following of this system would result in a card index which would point to where the latest information upon power-plant subjects could be obtained, and if the articles are filed or the papers containing them saved and the index card is made to point to their location, a veritable encyclopedia of the business would in time result.

## A Record Breaking Turbine Test

The reported performance of a Brown, Boveri turbine at Newcastle-upon-Tyne, particulars of which will be found upon page 599, beats the record so far as we know of published actual accomplishment in British thermal units per kilowatt-hour referred to the total work done by the turbine with an overall efficiency of ninety per cent. There are turbines which have made records under other conditions of pressure, superheat and vacuum which, could they be reduced to these better conditions, would better this performance, but for actual accomplishment this is the best so far reported.

The United States Supreme Court has sustained the commodity clause in the Hepburn rate bill, forbidding coal-carrying railroads from owning coal mines. Just notice how much difference this will make in the price of coal.

There are some engineers who are "old fashioned" enough to believe that the more simple a power plant is in design the more economical it is in operation. They have no use for frills and at that some of them are getting results.

Have you seen helpers who could not, or would not, learn the lesson of obedience? They consider it degrading to a free-born white man to take and obey orders.

An engineer cannot expect to accomplish much unless he has self-confidence.

Some managers employ cheap help and use cheap material, and are surprised that they get poor results.

Have you noticed that some engineers keep an open tin filled with cylinder oil in a warm spot so that dust from the coal, ashes and sweepings can readily settle into it?

When a power-plant owner is losing money and does not know it, it does not worry him.

It isn't so much what you do as the way you do it that counts toward success.

Do it now; tomorrow may be too late—too late even to be sorry.

Have you ever taken the trouble to personally examine the inside and outside of the boilers in the plant where you are chief?

Activity is contagious. Therefore, a lazy chief engineer cannot blame his assistants if they follow his example.

An honest man is respected by all; a grafter by none.

# Government Control of Water Powers

*A summary of the papers presented at a public conference on "The proper attitude of the National and State Governments Toward the Development and Utilization of Water Powers," held under the auspices of the power transmission section of the National Electric Light Association.*

The conference was held at the United Engineering Societies building in New York City on April 8. Walter L. Fisher, Secretary of the Interior, and a large number of prominent engineers and water-power men from various parts of the country were present. Chairman H. L. Doherty opened the meeting with the following remarks:

The National Electric Light Association is an organization of corporations and individuals engaged in the electric-light and power business, which now exceeds 7000 members and represents over 80 per cent. of the money invested in the electric-light and power business in this country. It was organized to encourage the development of electric service from central-station plants along broad and comprehensive lines, which will bring benefit to the members of the organization and to the public.

According to the last census there is 37,000,000 horsepower available in the United States in water power which can be developed at a cost comparing favorably with that of steam. Of this amount about 1,600,000 horsepower has already been developed electrically and approximately 1,900,000 horsepower has been developed for industrial purposes through means other than electrical, leaving approximately 33,500,000 horsepower still available. To develop even the smaller amount of power named would require over $7,000,000,000.

It is interesting to note that the undeveloped water powers of this country exceed the total amount of power now generated by all known means. However, the bulk of these powers is located in mountainous regions, while the great bulk of all the power now generated is along the populous sea coast and plains districts and often far away from these water powers. The question of electric transmission of power is purely one of economy and reliability. Given enough money for the equipment, it would be possible to transmit power from San Francisco to New York with no greater loss of energy than now occurs on many ten-mile transmission lines. Power is already being successfully transmitted over distances of more than 200 miles.

At present over $200,000,000 worth of fuel is being consumed annually which might be saved by the development of our water powers. In the movement toward the conservation of our natural resources it must be evident to all that the resource which is greatest in danger of exhaustion, and which should be conserved, is the fuel supply. It is interesting to note that under the teachings of this so called "conservation" movement the National, and to a large extent the State governments, have assumed an attitude which has almost completely discouraged the development of water power and is causing every day an unnecessary and flagrant waste of the fuel supply. The development of our waterpowers represents an enormous source of available wealth to the community as a whole, but it does not promise the reward to the promoters and backers of these enterprises equivalent to that which is promised in almost every ordinary line of business.

The Government cannot give title to a water-power site that would warrant the erection of a $600 miner's hut. Undertakings requiring millions of dollars are expected to accept such a title to the property which is to be improved, and yet the title can be revoked at will, even on caprice of a governmental agent. The National Government has committed itself to a policy of limited tenure of grant, which is contrary to the opinion of all of the advanced thinkers in the school of economics, and a policy which is wrong in principle.

It has been suggested that this controversy may be partially due to an unrecognized difference in the fundamental premises which have been unconsciously assumed without careful analysis. By this is meant that one class, taught by the more recent and impractical school, assumes that the public lands are the absolute property of the Government, intended only to enrich the treasury of the Government without regard to other considerations; while the older and more practical school assumes that these lands are held in the nature of a trust and should be used for the settlement and development of the territory where they are situated, and thus contribute to the development of the entire country. The latter school is in accord with the precedents which actuated the Government through many decades, and, although precedent alone should not govern in matters of this sort, there is a consideration which precedent in this case has injected, and which is of prime national importance. The Government has from time to time dealt out vast areas of these public lands under the guidance and advice of the early statesmen of this country, selling or giving away these lands for a mere fraction of what their ultimate value would prove to be, believing that the benefit of quick settlement would bring about by earlier use vastly more in the development and prosperity of the country than to permit these lands and opportunities to lie unproductive for many years.

This policy had the support of all the great statesmen of all parties from the country's birth until in the last few years, but it may be that the men we reverence who formulated and executed these policies lacked the wisdom of our later-day magazine-made-hero statesmen, but in spite of this later-day wisdom why does not fair play demand that the public lands and opportunities of Oregon, Washington and Colorado be utilized to develop these sections rather than to have the public lands of these and other States treated as public property, owned in fee simple by the Federal Government and used to enrich those States that have already had distribution of their public lands according to the policies of the old school.

## Conservation of Water Powers and Their Development for the Public Good

By Sidney Z. Mitchell

The real conservation of water power means its use. The only methods of producing this power are (*a*) through the consumption of coal, oil, gas, wood and other fuels which exist in limited quantities and cannot be replaced, and which are being consumed and exhausted at a rapid rate; and (*b*) through the use of water powers.

Under the first method, natural resources which cannot be replaced are consumed. It has been estimated that there are now being annually used in the United States more than four hundred and eighty million tons of coal, worth, on an average, $2 per ton, or a total of about $960,000,000 annually, to say nothing of the annual consumption, in addition, of millions of dollars' worth of oil, natural gas and wood. In many places entire forests are being denuded to obtain the fuel supply for local uses when the same purpose could be better served by the development of hydroelectric power from nearby streams.

By the second method, that is, by the use of water power, this frightful con-

sumption of coal, wood and other fuels can be minimized and in many cases wholly obviated, and in that way the natural resources, which are limited in quantity and which are now being so rapidly exhausted, will be conserved.

The distinction between water powers operated for private purposes and those operated for public purposes seems to me so logical and so important that it must be recognized in future legislation. Too much emphasis cannot be laid upon the radical difference between the pulp mill or factory type of water power used entirely in a private business and the water power used for the generation and distribution of light, heat and power. The latter is the servant of a widely scattered public, serving, without distinction, all the people, including manufacturers, domestic consumers, traction lines and municipalities. In the truest sense of the word it a public-service business, and as such there can be no doubt of the power of the Government to exercise over its service and charges the most minute and continuous supervision and control. The only restriction upon this power is that there must not be confiscation of the property in which capital has been invested.

There has been a great deal of discussion as to the relative legal rights of the Federal and State governments as bearing on water powers. These I will not attempt to discuss. So far as I have been able to ascertain, the majority of investors have no particular preference in the matter; but are vitally interested in having their public-service investments regulated by only one authority. And it seems to me that the possibility of having one government passing laws that the officers of a corporation shall conduct a business in a certain way and in no other, and another equally potent government passing laws requiring these same officers to conduct the public-service company's business in a different way, and in no other, needs only to be stated to show that such conflict of laws would be fatal.

Contrary to the general belief the charges which the Government, State or Federal, may make for the privilege of using the water powers is not a matter of material importance to the power companies, so long as such charges are not so great as to make it impracticable for the power company to compete with steam- or gas-producer plants, or with other water-power companies exempt from such special tax. It may seem desirable to the Government that an annual charge be made. To my mind this is merely one of the methods of providing State or Federal revenues at the expense of the particular community served. I believe that so long as the charges are not so high as to prevent the substitution of water power for fuel-consuming power, the matter is entirely one of equitable taxation, in which the only interested parties are the Government and the local community paying the tax. For, if made, such charge must be taken into account in the regulation of rates, and will proportionately raise the limit below which prices to the consumer cannot constitutionally be reduced.

It is important also to bear in mind some of the undesirable complications which may grow out of this method of taxation where the power developer is forced to construct and donate to the Government expensive locks at the rapids of so called navigable streams. This large initial investment is in effect a lump sum tax upon the particular community served. It must necessarily be paid at the outset by way of construction costs. Without being unduly burdensome, however, it cannot be shifted upon the consumer in a short period. To minimize the sinking fund or amortization charges necessitated by this unusual and to my mind unwise expense, it is necessary to spread it over a long series of years. And to the extent that the spreading out of the charge is made impossible by the short tenures imposed by Congress in authorizing the building of the dams, to the same extent will these amortizations bear harshly upon the consumers of power and often prevent the substitution of water power for fuel-consuming power apparatus. In many cases this lump-sum method of tax is undoubtedly too much for a new industry to bear, and thus defeats the desire that all these water powers should be built.

Many of the largest and best unused water powers today are upon the so called navigable streams. An investor is asked by the local people to join in providing capital to develop such powers. He is at once confronted by the necessity of securing an act of Congress authorizing the construction of a dam across the rapids of the so called navigable stream, rapids over which in many cases no boat has ever passed, nor probably ever will pass until locks are constructed. In demanding that the power developer shall construct and present to the Government an elaborate system of locks as part of the construction of the dam, the Government overlooks the fact, not only that such construction must ultimately be paid for by the community served by the power company, but also that the very building of the dam across such rapids will relieve the Government of the great expense of creating the necessary pond over the rapids. If it should thereafter desire to make the rapids navigable it need pay only the then much smaller cost of building locks sufficient merely to put the boats into the pond created at the expense of the power builders. As a rule, water powers of this character involve the handling of large quantities of water at low head. This of itself makes development expensive and in many cases more or less unreliable, unless supplemented for short periods by steam, owing to the fact that extreme high and low water affects such development more seriously than high-head developments. These great burdens to the investor are increased many fold in most cases by arbitrary legislation, restrictions and limitations. These restrictions and harsh requirements, from a navigation standpoint wholly unnecessary, are today holding back the development of hundreds of thousands of horsepower, the operation of which would save millions of dollars' worth of fuel which is being consumed each year.

In some of the Eastern, Southern and Middle Western districts where coal is cheap, it is frequently difficult for engineers to decide whether it is more economical to develop water power or use the ever-improving steam and gas-producer power apparatus. Waterwheel construction has so advanced that it is not possible to materially increase the water efficiency. On the other hand, the efficiency of steam and gas-producer apparatus has been wonderfully improved in the past two decades, and will undoubtedly be further improved from year to year.

Where there is this close competition between the relative economies of water-power and fuel-consuming apparatus, and where the adoption of steam, oil or gas means a large unnecessary consumption of nonreplaceable fuels, is it not a pity that every possible power at the command of the Government, Federal, State and local, is not exerted to the utmost to secure the adoption of the water-power system and thus save the fuels? Very frequently the omission of all Governmental restraints (other than the power of regulation and those necessary to protect navigation) or a small difference of cost amounting to not more than the value of one or two years' fuel consumption by the equivalent steam or gas-producer plant, will turn the balance in favor of the water power.

The investor of today knows that his property on Government lands is inadequately protected. He demands permanent, tangible and specific rights; the mere shifting and changing permits now in effect scare off all but the most speculative class. At present the rights of the hydroelectric companies in the Forest Reserves, for instance, are subordinated to operators under the mining laws. If I am correctly informed, it is possible for a mining company to start placer or other mining operations, at the very dam or canal intake of the hydroelectric company, and to so interfere with the company's structures as to render the operating plant inoperative and, therefore, useless.

Moreover, under the present law, there is a question whether the Federal officials have power to grant or sell to the

hydroelectric companies any rights as against subsequent homesteaders, scrip locators or other entrymen, who may obtain title at any later time when the lands involved are thrown open to settlement. If there is no such authority, then any future scrip locaters, homesteaders or other entrymen on such lands have the right to take possession thereof as if the plant and property of the hydroelectric company had never existed. And in States which do not give hydroelectric companies the right of eminent domain, there would be no way to protect such investments against the arbitrary action or unreasonable demands of the subsequent scrip locaters, homesteaders or other entrymen, who would thus have the absolute power to eject the hydroelectric developer from the premises and thereby render inoperative his entire plant and investment.

Limited tenures may be well enough in the case of the development of a water power in connection with a private business which the Government has no right to regulate; but advanced thinkers on the subject, I believe, all agree that, next to revocable permits, limited tenures are the most fallacious and harmful of all the present-day popular notions, when applied to a water power, or any other development made for the public benefit.

A power developer may have three or four times as large an investment in his distributing system (entirely off the Government domain) as in the generating station on the Government domain. The whole distributing system would necessarily be made inoperative and useless by the failure to secure a renewal of the original limited tenure for the generating station, and is thus unduly jeopardized by the mere possibility that some Government official, actuated by political exigencies of the day, may fix the renewal terms on such an onerous basis as in effect to confiscate the power system as a whole. There is always the theory that these limited tenures will be renewed on some terms, but what these terms will be, what is the significance of the so called but very indefinite "preference right" of renewal, and, in fact, what is to become of the entire generating and distributing property at the end of the 50 years, no one seems to know.

We know that population and general business, particularly in the western sections, are growing by leaps and bounds. The requirements of the people both as to quantity and quality of service, including new uses of electricity, are daily increasing. Consequently, capital investment must be increased from day to day and from year to year if a corporation is to do its duty properly as a public servant and as the law requires. Who ever heard of a public-service corporation in the West, or even in the East, needing less plant and equipment and less facilities for serving the people from year to year as time goes on?

Why should any of our local communities be taxed with high rates from month to month in order to create a large amortization fund to pay for and present to the Federal Government at the end of 50 years or other limited tenure its local power developments? Why should the present generation be forced to pay exorbitant charges for service, to create this amortization fund, so that the property may in two or three generations revert to someone else?

If an amortization charge at the rate of so many cents per kilowatt-hour and so many dollars per horsepower-year for the entire plant capacity is necessary for the money invested during the first year of the 50-year tenure, then what must this rate be on every additional million dollars invested during, say, the twentieth year and during the thirtieth or fortieth year? And how it is possible for the consumer to pay a high enough rate in, say, the forty-fifth, forty-ninth and fiftieth years of the tenure, to return the investor at the end of the 50-year period all of his capital put in during these last few years and devoted to serving the people? Unless the investor receives positive and satisfactory assurance on this point, is he likely to come forward, particularly toward the end of the tenure, with the cash to provide the equipment and plant necessary for proper service of the people?

In the water-power business, without providing anything by way of an amortization fund, it usually takes, over a term of years, from $5 to $10 actual cash investment in plant and distributing system to get $1 per year gross revenue at such normal service rates as will provide a reasonable return on the investment and be commercially obtainable in competition with steam. Evidently, therefore, it is not only impracticable, but I can tell you from experience it is absolutely impossible, to charge only normal and reasonable rates for service, and devote all the earnings to providing for the growth, not unusual in the West, of 15 per cent. and upward per year, and at the same time have anything whatever left for interest and dividends. The cash required to provide facilities for such growth will, over a term of years, more than absorb the entire net earnings. How much more impossible, then, does the problem become if additional money put into the property toward the end of an expiring tenure must be gotten back through the creation of an amortization fund by raising the rates to the consumers?

All of us who have lived in the West, and who have had dealings with the farmers in the arid communities, have had forcibly brought to our notice still another fatal feature of the limited tenure theory. There are in the West many millions of acres of arid land which is the most fertile in the world when properly irrigated, but which is worthless without an adequate and reliable source of water supply. The lower levels of land are being supplied from Government or other irrigation canals, but fully as many acres of land on the higher levels can be commercially irrigated only through the use of hydroelectric power, the bulk of which is being furnished by public-service corporations in connection with their general light and power business. This arid land would be of no use without an unfailing water supply. But how is it possible for the power company to agree to furnish water in perpetuity for irrigating these lands, if there is the slightest chance of its source of supply being arbitrarily cut off under the present revocable-use agreement or limited-tenure system? Will there not inevitably be recurring periods of expiring tenures to cause complete stagnation of all productive effort dependent upon water power, disastrous alike to the community and to the power developer?

To my mind the only way this water-power question can be promptly and correctly solved, as a fuel conservation problem or otherwise, is by so educating the people on every phase of the subject that they will not only support and approve, but will insist upon the adequate and sane legislation now so much needed. The objects of this association are largely educational, and I know of no way in which it can better serve the people, including its members, than by taking a leading part in this educational campaign for true conservation.

### Discussion

Several other papers and discussion of a more or less general nature were presented before the meeting. Space is not available in this issue even to give a summary of much of this material. Some of it, however, not included in the following will be given attention in a later issue.

*Walter L. Fisher*, Secretary of the Interior: Fundamentally there is no conflict between the State and Nation in this matter, but no correct solution of the subject will be reached until all possibility of real conflict, justifiable conflict, has been removed. I believe that the State and Nation should be coördinated in a solution of this problem, and that they can be and will be when the correct solution is reached.

The expression has crept into the remarks of the chairman that there is existing a Governmental policy which seems to be subject to some criticism, or at least some dissatisfaction. I think that is a fundamental mistake. As I understand the existing situation, there is no Governmental policy, and that is the chief fault of the existing situation. What the Government has been doing, as I understand it, is merely to maintain the

existing status until a policy can be developed.

To my mind, the most essential thing in this whole matter is that we do get together, that we do try to understand each other, and then that we act. The time has come when discussion is useful as a basis only for forward action, and I welcome this meeting as one of the first steps in that direction.

*J. G. White:* It seems to me, from the ordinary business point of view, that conservation properly means "saving what is otherwise going to waste," and that would necessarily mean utilizing the water powers instead of throwing hindrances which either prevent or divert such utilization. Every hour that any particular stream on which water power could be developed is allowed to go without such development, a certain amount of energy is being wasted, and being wasted beyond recovery. On the other hand, the coal which may be used from time to time to develop the energy, in place of the water power, might rest in the ground for a decade, or a century, or any time, with little or no deterioration. If the Government officials could all, as most of them do really, think of it as a fundamental proposition, from a practical and businesslike point of view, and then see how they could help to enlighten members of Congress on the subject, seeking to arouse their interest in a study of the subject, and others who perhaps for the sake of curr ing favor with the political elements, or whatever their object may be, could be gotten to take a businesslike point of view on this proposition, and then all work together to the end of arousing the interest of the Government officers in charge to look at it from a business point of view, I have no doubt that most of these problems could be settled along sane lines.

While the so called water-power privileges might be given in the shape of Government permits, with the right to revoke such permits, I do not believe, unless there should be a wholesale change in the tenor of affairs, that that authority would be used to the detriment of the people who had invested their money in good faith; but in spite of that, it is my thought that there should be a clear and businesslike appreciation of this general problem, and it would seem to me that some resolutions, either advocating the appointment of committees to give special consideration to the problem, and to make a report to Congress, or having a report from the Government engineers to Congress, for the consideration of Congress, looking toward legislation which would be along business lines, should be advocated by this body.

*John H. Finney:* A policy that makes for continued nonuse does not fit the true definition of conservation, which is wise use, and for much of this the power companies are themselves to blame, just as the railways have been to blame for radical legislation directed against themselves. The time for the "public be damned" attitude, for frenzied finance, for secrecy of operation, for extravagant profits, for unrestricted perpetual rights and franchises, is past. The time is here and now for the exact analysis of all these things; the sooner it is recognized by capital and exploiters, the sooner will we get that better understanding that will make wise use and fair dealing possible. I am no prophet, but it seems to me that it is clearly possible that fair dealing and wise use may in time rest not on the Government control of navigation, which is now wrongly considered by the Government as the paramount use of water, but on the broader public-welfare clause of the constitution, which will consider the larger and more important and valuable water power, made possible by a well considered and coördinated plan of river development, as the important thing concerning which the people require education—I do not know anything upon which Congress would require more expert knowledge than in dealing with these matters, and the function of this body should be wisely directed toward the education of Congress to the importance of water power now, and the supreme importance of water power in the future.

*Charles F. Scott:* The relations of the public to water powers, the rights of the public in water powers, it seems to me is something that changes from time to time. It has been pointed out that the rights in early days, when there was no use of water except along the banks of a stream, were such that the rights were granted entirely to those who occupied the borders of the stream; and later, when water began to be useful for irrigation at a distance of a mile or so from the banks of the stream, then the people occupying the adjacent country were found to have rights in the stream because they were found to have a use for the stream which never existed before. Likewise, when people fifty miles away have use for the power which the stream can develop, then rights, generally moral rights, and later legal rights, are created which did not before exist; and it is to meet new conditions of that kind, for which our laws are obviously inadequate—not that there has been a fault in the past, for it would be as impossible for the legal machinery of our Government to have anticipated these conditions twenty years ago, and provide for them, as it would have been for the electrical engineers of that day to have laid out the power plants of the present day—it is a matter of normal evolution, brought about through these new scientific and engineering developments.

If we were in a few words to state what is the real problem, the general problem now before us, it seems to me it would be this: To formulate a constructive policy by which water powers may be made available to the public at fair and equitable rates. I think when we consider for a moment the various phases of the questions that have come up, that all of them resolve themselves finally down to that simple proposition—how can this power be made available in the most efficient way to the public at fair and equitable rates? The great public cry, I believe, is against "interests" getting hold of water powers in such way that they may extract an undue profit. If, therefore, we can insure by Governmental control that that power shall be made available to the public at fair rates, we have accomplished the purpose which we want to accomplish.

*D. B. Rushmore:* My feeling toward the Government is that it is not an opposing force—it is fighting for us, it represents us, it is ourselves, and we want the Government to help us, the people, to carry out these enterprises. A sudden brake has been put on, partly because people do not understand, and they wanted to stop it until they got the thing right.

Very few individuals now question the right or desirability of public supervision and public regulation, but they want it in a fair-minded way, and engineers ask that it be done in an understandable way. Now, when a supervising body states that on a certain system the current and the voltage must be kept at a constant value, twenty-four hours in the day, it appears absolutely ridiculous, and we know at once that the men, with the best of intentions, making these rules, do not know what they are talking about. The result of conferences like this, and future conferences for interchange of opinion, will be that the people who will have the control and supervision of these enterprises, will be able to exercise this control and supervision in an understanding way.

### Resolution Adopted

At the close of the meeting the following resolution was read and adopted by the society:

Resolved, That it is the sense of this meeting convened at the instance of the power-transmission section of the national body, that the National Electric Light Association should offer its coöperation with the legislative and executive branches of the National and State governments for the formulation of a definite constructive policy which will encourage the prompt and fullest development of our water powers in the public interest; and

Be It Further Resolved, That to this end it is recommended that the officers of the National Electric Light Association appoint a committee or committees, with power to act in the premises, and to invite the coöperation of such engineering, commercial and other bodies as they may deem expedient.

# New Power House Equipment

*What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news*

## Indicator Spring Tester

This apparatus, which is made by the Schaeffer & Budenberg Manufacturing Company, Kent and De Kalb avenues, Brooklyn, N. Y., consists essentially of a closed vessel made of cast iron, capable of resisting internal steam pressures up to 200 pounds per square inch. The steam pressure in the vessel is measured by a gage of special construction consisting of a piston, of ½ square inch area, which is free to move in a cylinder.

The lower portion of the piston is pointed and rests in a yoke which is suspended on the knife-edge of a pair of scales mounted on top of the closed vessel. If the scales are previously balanced, before admitting steam into the vessel, it is evident that the reading of the scales will give the pressure acting on each element of the vessel equal in area to that of the piston. The scales are graduated to fiftieths of a pound, which permits very close readings. The device is shown in Fig. 1.

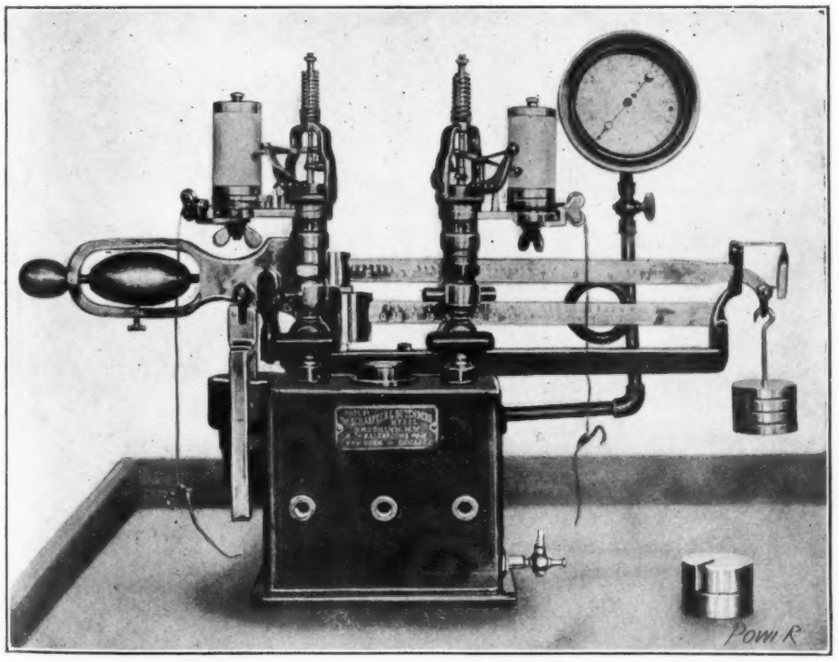



FIG. 1. INDICATOR SPRING TESTER

In testing indicator springs, steam is turned into the vessel to gradually warm it and is allowed to blow through the connections and indicator cocks to remove any particles of dust or grit which may have accumulated therein. Steam is then shut off and the indicator put in its place and paper put on the indicator drum, on which paper two vertical lines are ruled as shown at the lines *A B* and *C D* in Fig. 2.

The indicator pencil is pressed against the drum and a horizontal line *Q Q* drawn at the point thus marked. The poise of the scale is set at say 5 pounds, and steam is admitted to the vessel, gradually rising in pressure until the scale floats. When the pressure is exact, the line *R R* is drawn, and so on for successive pressures of 5 pounds until the limit of the scale is reached. During this operation the motion of the indicator pencil is continuously kept upward and if at any moment the pressure rises too high it is lowered by manipulating the valve below the required amount and then gradually raised to the desired point.

When the indicator pencil has reached its highest position the steam pressure is allowed to fall gradually and a series of similar lines, as *W W*, *X X*, *Y Y* and *Z Z*, are drawn during the descent of the piston, the motion being continuously downward. The distance between any two of these lines, as *Z R*, *Y S*, indicates the loss due to the friction of the indicator.

This testing apparatus also serves for testing pressure gages which can be connected to the three openings in the front side of the vessel provided for that purpose. The readings are verified by the indications on the scales and the test gage shown in Fig. 1.

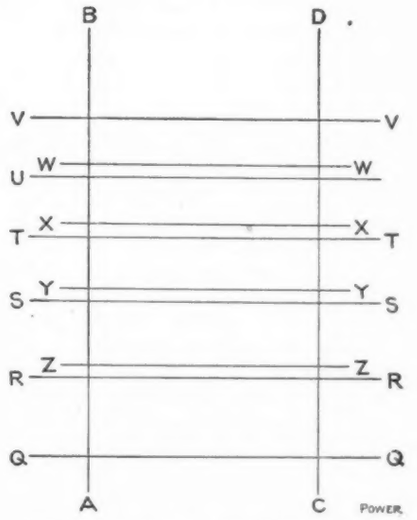



FIG. 2. LINES SHOWING LOSS DUE TO FRICTION

## Belt Lace and Leather Cutting Tool

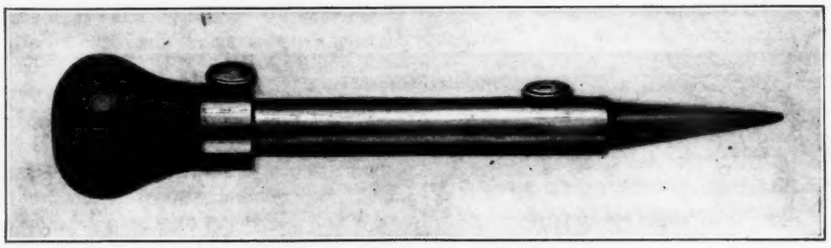
This tool is 7 inches long and has a body ⅝ inch in diameter. It consists of an adjustable knife blade for cutting belts and belt lacing. On one end of the body an adjustable gage can be attached for cutting lacing of various widths from rawhide skins.

The opposite end of the knife is made in the shape of a half-wound reamer, pointed at the outer end. This serves the purpose of cutting about 40 different-sized holes in a belt and is extremely useful when lacing wide belts.

In starting a hole in a belt with the reamer, it is turned to the right and left with a gradual pressure exerted on the handle until the reamer has been pushed through the belt. Then a full turn is

made until the desired size of hole is obtained.

The reamer or knife can be used by reversing the detachable handle, which is held in place by a thumb screw. This device is manufactured by the Kane & Christie Manufacturing Company, 118 Greene street, New York City.



BELT LACE AND LEATHER-CUTTING TOOL

## "Model B" Rochester Lubricator

This force-feed lubricator is built substantially the same as the standard Rochester lubricator, the difference being in the arrangement of the driving gear. The stock size of the "Model B" lubricator holds three pints but other sizes having capacities of from ½ pint to 2 gallons can be furnished. It is designed for high-speed engines running from 200 up to 400 revolutions per minute.

The oil reservoir is fitted with a gage glass to indicate the hight of the oil, which is drawn from the main reservoir and forced to the steam pipe leading to the engine by means of a small plunger pump that is actuated by an arm attached to a vertical shaft. This shaft receives its motion from a cam that is driven by means of two hardened-steel ratchet wheels, which are cammed together and cammed apart by the action of the actuating arm. These ratchet wheels operate a series of cog wheels which in turn operate the main shaft of the lubricator.

By means of these cog wheels the outside ratchet gear revolves 10 times to one revolution of the cam driving the pump plunger. This feature makes the lubricator capable of doing good work on high-speed engines. A special advantage is that the reduction of wear and tear in the lubricator is greatly reduced over what it would be with the standard arrangement, operating at high speed.

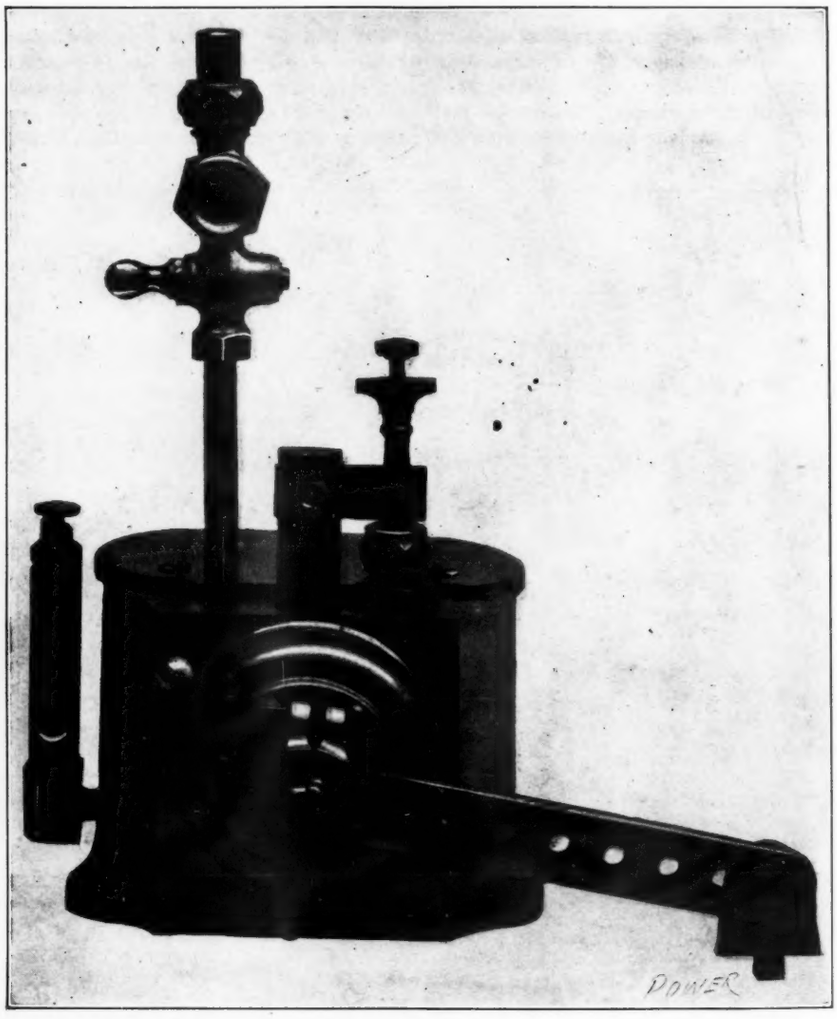
The driving mechanism is inclosed in a dust-proof steel cover. The motion to the ratchet gears is obtained from the lever which is connected to a reciprocating part of the engine.

There are three methods of adjusting the amount of oil fed to the engine. One is by changing the position of the adjusting arm, which is made by loosening the bolt in the actuating arm and moving the arm to the right or left as desired. This causes more or less lost motion between the cam on the lever and the ratchet gear; therefore the teeth of the ratchet wheels are engaged for a greater or less portion of the stroke.

Another adjustment is accomplished by a screw in the top of the plunger, shown in the accompanying illustration, and a third adjustment is made by changing the position of the rod connection on the actuating arm, for which purpose holes are provided.

By changing the inner ratchet wheel and substituting one that is not filled with cog gears a "Type A" lubricator can be had, the difference between the two types being that the plunger of the latter makes one stroke for each revolution of the ratchet gear. In other respects the "Model A" is identically the same as that of the "Model B" lubricator.

These lubricators are manufactured by Greene, Tweed & Co., 109 Duane street, New York City.




VIEW OF "MODEL B" ROCHESTER LUBRICATOR

## The H. and B. Steam Drier

The H. and B. steam drier, manufactured by Edward C. Garratt & Co., 25 South Clinton street, Chicago, Ill., is designed to separate excessive moisture from steam before it leaves the boiler, and the water, thus separated, remains in the boiler and permits the steam to pass into the steam piping in a dry state.

The accompanying diagram, Fig. 1, is a partial sectional view of this steam drier, as installed in the dome of a boiler; it is placed directly under the main stop-valve connection, where the steam must

pass through it when leaving the boiler.

Steam passes through the drier as follows: Entering at the top, it travels

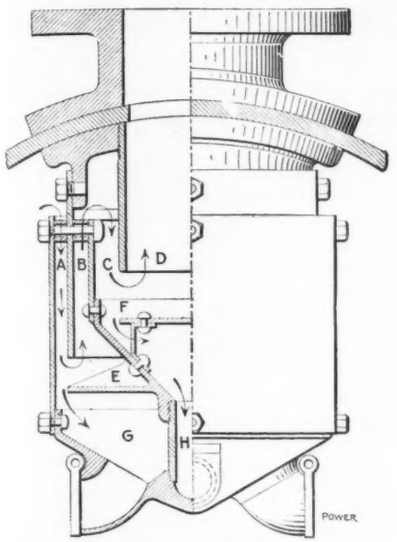



FIG. 1. SECTIONAL VIEW OF DRIER

downward through the passage *A*, as shown by the arrow, traveling at the same velocity as it rises, thus separating some of the excessive water that has been

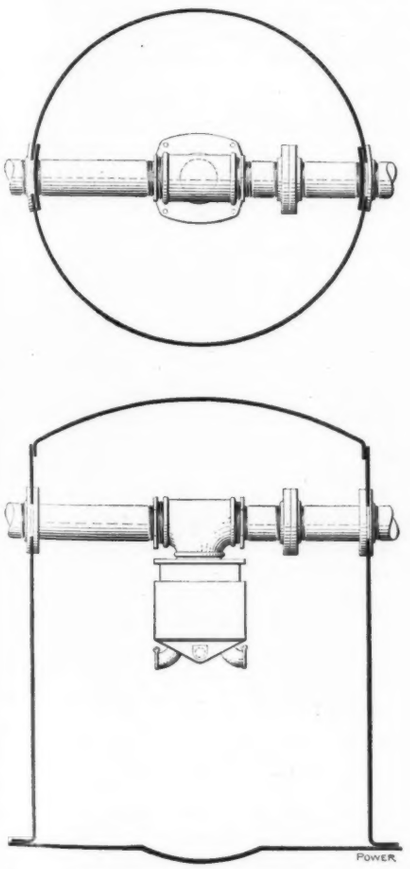



FIG. 2. DRIER CONNECTED TO STEAM PIPE

drawn in by the steam and throwing it under the baffle plate *E* causes it to return to the water level through the drains *G*. The steam passes through a similar process at *C* and *D* and baffle plate *F*, where any moisture that might have passed *E* is expelled through the smaller drain *H*.

The manner of installation varies according to the design or type of boiler.

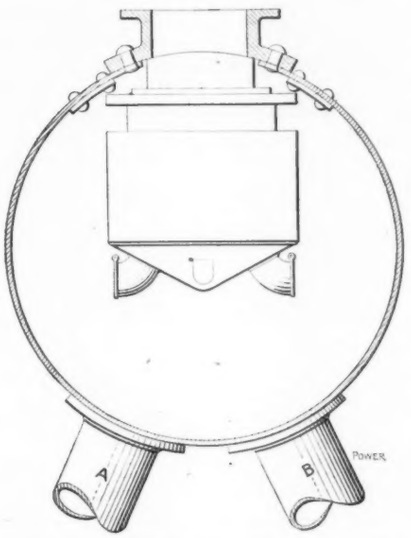



FIG. 3. DRIER PLACED IN A RECEIVER

In some cases the drier is connected direct to the piping, as shown in Fig. 2, and all of the steam used from the boiler, either to the main engine or auxiliaries, passes through the drier.

Fig. 3 shows a drier installed in a drum that acts as a common receiver for two boilers and takes care of the moisture in the steam passing through the two supply pipes *A* and *B* from the boiler.

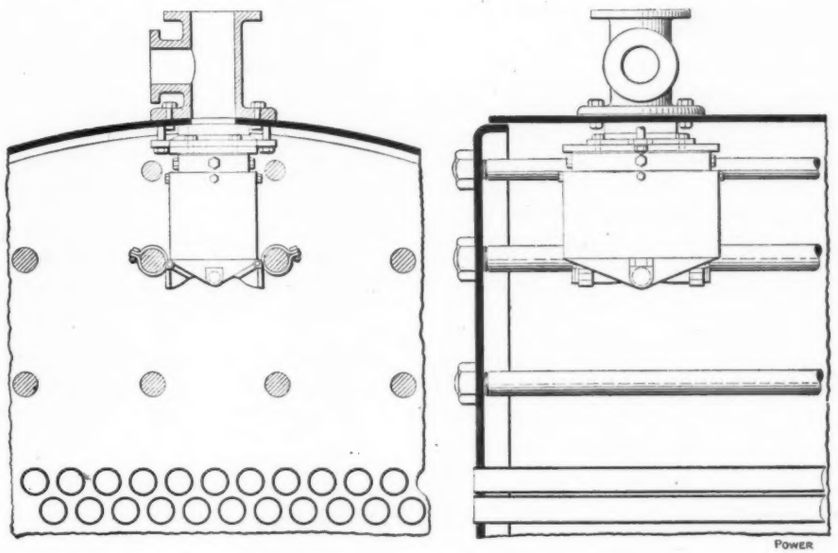



FIG. 4. DRIER INSTALLED IN SCOTCH BOILER

Fig. 4 shows the drier installed in a Scotch marine boiler. In case the longitudinal stays in the boiler are close together, the drier can be built oblong in shape to get the required areas; sufficient areas are always allowed, in the various steam passages of the drier, to prevent the steam from being wiredrawn.

## Atlantic Mills, at Providence Enlarge Plant

With the object of concentrating their power plant and eventually operating all their machinery by electricity, the Atlantic Mills, of Providence, R. I., have just completed a large addition to their boiler house. Eight new boilers, 250 horsepower each, of the Manning type, built by the Dillon Steam Boiler Company, of Fitchburg, Mass., have been installed within the past year, four being used for the first time two weeks ago, and it is planned to add eight more, with an additional turbine. The scheme is to derive power from two turbines, one condensing and the other noncondensing, using the exhaust steam from the noncondensing unit for heating and manufacturing purposes.

The company believes that by centralizing the plant and using turbines they will save money and labor, occupy less space and also save exhaust steam.

At present the mills are being operated from three power houses, one containing a 1500-horsepower Corliss cross-compound engine with a 32-foot gear driving the jack shaft instead of belting. This engine is run by seven boilers of 200 horsepower each. In the second there are two belt-driven generators of 500 and 350 kilovolt-amperes capacity. In the station where all the units are to be assembled, there is a 1500-kilovolt-ampere Westinghouse Parsons noncondensing turbine.

A new 175-foot radial-brick chimney, built by the M. W. Kellogg Company, of New York, has been erected to serve the additional boilers.

## Boiler Explosion at Mt. Washington, Kentucky

One person was instantly killed and four others were hurt, two probably fatally, when a boiler of a traction engine operating the sawmill of Brumley & Jones exploded on Thursday, April 6, at 10:15 a.m.

The accident occurred in the woods, on the farm of John Cornell, on Drake branch a mile below Whitfield in Bullitt county. The explosion was heard for miles around and caused much excitement. The injured members of the party summoned assistance from the nearest farm houses and physicians hastened to the scene. The young man who was killed was standing beside the engine, of which his brother, who was the engineer, had charge, when the boiler let go. His body was literally torn to pieces.

The engineer was scalded about the face and internally injured. It is feared that his eyesight will be permanently effected.

A laborer employed in carrying lumber from the mill was frightfully scalded and it is thought that his injuries will prove fatal.

The boiler let go without the slightest warning and caught the crew entirely unaware of the impending danger. Pieces of the wreck were picked up hundreds of yards from where the accident occurred. It is said that the engine was comparatively new and the cause of the explosion remains unexplained.

## Joint Meeting of Machinery Dealers and Manufacturers

With an attendance of nearly 600 the annual triple convention of the Southern and National Supply and Machinery Dealers' Associations and the American Supply and Machinery Manufacturers' Association was held at the Seelbach hotel, Louisville, Ky., April 3, 4 and 5.

Opening addresses were made by Gov. Augustus E. Willson, William Heyburn and Pendleton C. Beckley upon behalf of Kentucky and Louisville, while Edward C. Hinman, W. M. Patterson and S. P. Browning responded for the associations.

Executive sessions occupied most of the daylight hours, during which were discussed important matters connected with the business end of the various manufacturing establishments represented.

Entertainment of the most hospitable kind was not lacking and all the visitors will be heartily in favor of Louisville as the scene of another annual convention in the not far distant future.

On Thursday the convention left in a body for a visit to Mammoth Cave, this trip constituting one of the most enjoyable social features of the meeting.

Officers were elected as follows: For the American Supply and Manufacturers' Association, Willard Parker, president, Spring City, Penn.; N. A. Gladding, first vice-president, Indianapolis, Ind.; D. K. Swartwout, second vice-president, Cleveland, O.; C. H. Jenkins, third vice-president, Louisville, Ky.

Officers for the Southern Supply and Machinery Dealers' Association: W. P. Simpson, president, New Orleans; S. M. Price, first vice-president, Norfolk, Va.; I. F. Young, second vice-president, Birmingham, Ala.; Alvin M. Smith, secretary and treasurer, Richmond, Va., reëlected.

For the National Supply and Machinery Dealers' Association: W. L. Rogers, first vice-president, New York City; J. O. Herron, second vice-president, San Francisco; Thomas A. Fernly, secretary and treasurer, Philadelphia, Penn.

Representatives of Norfolk, Va.; Asheville, N. C.; Dallas, Tex., and other cities presented invitations for the joint triple convention to meet with them next year. Complimentary references were made to all of these cities. The selection of a meeting place, however, will not come up until later. Asheville seems to have a shade the better of the argument, judging by the expression of the delegates.

# PERSONAL

Frank T. Clarke, M. E., who has been located at Los Angeles, Cal., has opened an office as consulting engineer at Honolulu.

C. M. French has been transferred from the Deane Steam Pump Company, at Holyoke, Mass., to the Cleveland office of the International Steam Pump Company.

C. H. Pearson, formerly with the Noera Manufacturing Company, of Waterbury, Conn., has accepted a position in the hoist department of the Yale & Towne Manufacturing Company. Mr. Pearson's field of operation will be in the West.

On Monday evening, April 4, twenty-five of the officers and members of Colorado No. 1, National Association of Stationary Engineers, tendered James Merrick a surprise and farewell banquet in the Albany hotel in Denver. Mr. Merrick has filled practically every office in the association during the last five years with credit to himself and honor to the fraternity. He was this year filling the office of vice-president of No. 1, which he has resigned, as well as his position as chief engineer of the Denver Gas and Electric building, to accept a position on the sales force of the Dearborn Drug and Chemical Company, taking charge of the Salt Lake City office.

# OBITUARY

James C. Bradford, who built the boiler for the "Monitor" during the Civil War, and who has been engaged in other lines of the business since that time, died at his home in West Medford, Mass., on April 10. He was 82 years old. Mr. Bradford was in charge of the Rhode Island Locomotive Company's plant for several years and was master mechanic of the Providence-Springfield Railroad Company during the period of its building.

He was a direct descendant of Governor Bradford, who came over in the "Mayflower" and headed the Plymouth colony. He was born in Taunton, where he received his education. He learned the machinists' trade in Boston in the Old Colony Railroad shops. He left this company to take charge of the building and development of the Fairhaven-Boston Railroad.

Just prior to the Civil War he started a boiler business in New Bedford, Mass., and continued in it for nearly 15 years. While there he built the boiler that was used in the "cheesebox on a raft"—the "Monitor"—and did much other Government work during the war. From New Bedford he went to Providence, R. I., to take charge of the Rhode Island Locomotive Company's plant, and remained there until he took a position as master mechanic of the Providence-Springfield railroad, which was absorbed by the New York, New Haven & Hartford Company.

# SOCIETY NOTES

The eighteenth annual convention of the Oil Mill Superintendents Association will convene in Galveston, Tex., May 25, 26 and 27.

At Philadelphia on April 22 a meeting of the American Society of Mechanical Engineers will be held at the Engineers' Club. The subject for discussion will be "The Recent Work of the United States Fuel Testing Plant."

On April 21 the Boston sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers and the Boston Society of Civil Engineers will hold a joint meeting at which a paper will be presented by B. R. T. Collins, with the Stone & Webster Corporation, Boston, on "Oil Fuel for Steam Boilers." The paper deals with the possible use of oil fuel for steam-generating purposes in the Atlantic coast States, its safety and permanency of supply, as well as conditions under which it may have special advantages over coal.

# BOOKS RECEIVED

PRINCIPLES OF MACHINE WORK. By Robert H. Smith. Industrial Education Book Company, Boston, Mass. Cloth; 388 pages, 4¾x8 inches; 434 illustrations; indexed. Price, $3.

ELEMENTS OF MACHINE WORK. By Robert H. Smith. Industrial Education Book Company, Boston, Mass. Cloth; 192 pages, 4¾x8 inches; 204 illustrations; tables; indexed. Price, $2.

# Moments with the Ad. Editor

*A department for subscribers edited by the advertising service department of Power*

ONE morning a few years ago a peculiarly interesting story came out in the New York newspapers. It stated that the town of Brownsville, Texas, had involuntarily seceded from the Union—

That during the recent heavy rains the Rio Grande River had swelled, overflowed its banks and pursued a new and original course across the country—

That by this change of route the Rio Grande, instead of flowing in its time-honored bed *south* of Brownsville, now ran in a new course fifteen miles *north* of that growing town—

And that, as the Rio Grande River was the boundary between the United States and Mexico, Brownsville was now thrown south of the river and was, therefore, in Mexico!

After reading this article, the writer, being of a more or less skeptical nature, dropped a line to the postmaster of Brownsville asking him how much truth there was in the startling report.

About three weeks later he received a lengthy, wrathful letter from the Texas P.M.

It said, in effect: "There is no truth at all in the story. The Rio Grande hasn't changed its course an inch and even if it did this foolish dream couldn't happen—the boundary line is absolutely fixed by the treaty between the United States and Mexico. If the Rio Grande turned and ran up to Oregon the boundary would remain unchanged and Brownsville would still be an American town.

"The story was sent out by a promoter who thought any kind of publicity would pay—and nothing has done us more harm than the circulation of this ridiculous report.

"What we want to advertise to prospective settlers from the North is that, by coming to Brownsville, they can become prosperous *Americans*—not Greasers."

The point at once struck us that it was the promoter, and not the Rio Grande, that had overstepped the boundary.

He was attracting attention to his product, Brownsville, by making false statements about it. He thought he was an advertising man when really he was only a press agent. He told a lie to incite curiosity instead of telling the truth to inspire confidence. His fanciful story had to be authoritatively denied broadcast before the tide of home-seekers again turned toward the Texas town.

That this principle of profitable advertising has become gospel today you can see by reading the ads in your paper.

It would be business suicide for an advertiser in POWER to print a "Brownsville" story over his name.

The modern manufacturer works on a different method.

He spends his time, his brains and his money to make his product so good and so reliable that, when it comes to advertising it, the *strongest* things he can say about it are the *true* ones.

This is why the advertising pages of your technical paper are so informative.

It's why many a man today reads the advertising section before he does the reading matter—but don't tell the editors we said so.

# BUSINESS ITEMS

The Oliver Chilled Plow Works, South Bend, Ind., has recently placed its third order for Swartwout rotary ball-bearing ventilators. This new type of ventilator is made by the Ohio Blower Company, Cleveland, Ohio, manufacturer of the Swartwout steam specialties.

W. C. DuComb, formerly with the Otto Gas Engine Works and the Standard Roller Bearing Company, has become connected with the selling department of the Royersford Foundry and Machine Company, of Philadelphia, Penn., and will in future push the sales of the Sells roller bearings.

Through an agreement entered into between the International Acheson Graphite Company and the Acheson Oildag Company, the first named company on April 1 became general agents in the United States for the sale of the new lubricants, Oildag and Aquadag, products of the second-named company. This means that the trade will in the future be supplied with Oildag and Aquadag by the International Acheson Graphite Company, of Niagara Falls, N. Y., which places this company in touch with the sale of lubricants that meet all needs, inasmuch as the company itself makes Gredag, a lubricant which contains disintegrated Acheson graphite and grease, while Oildag is deflocculated Acheson graphite and oil, and Aquadag is deflocculated Acheson graphite and water. All Acheson graphite is made in the electric furnace. The production of Acheson graphite last year was over 13,000,000 pounds.

# NEW EQUIPMENT

Troy, Idaho, will install a new waterworks system.

Avon, Mass., will spend $15,000 on a new sewer system.

A. E. Coffin, New Bedford, Mass., will install a boiler.

Grace Hospital, New Haven, Conn., will install a boiler.

Ridgetown, Ont., will install a $50,000 pumping system.

Dexter, Iowa, has voted bonds for a municipal gas plant.

Watrous, Sask., will install a complete electric-light plant.

Dexter, Minn., has voted to install a waterworks system.

Kerrisdale, B. C., will equip a $175,000 waterworks pumping plant.

The Gardner (Mass.) Electric Light Company will enlarge its plant.

Danvers, Mass., is contemplating the erection of a new power house.

Tarrytown, N. Y., has voted to spend $70,000 on its water system.

Sherbrooke (Que.) will build a new power house for the city railway.

The Copley Trust Company, Boston, Mass., will install boiler and pump.

The board of trustees, Bisbee, Ariz., will install a new pumping plant.

Radcliffe College, Cambridge, Mass., will install a 50-horsepower tubular boiler.

The Moosejaw (Sask.) Electric Railway Company will build a new power house.

The Diamond Ice Company, Stamford, Conn., will erect a cold-storage plant.

The Rutland (Vt.) Railway, Light and Power Company will extend its plant.

Clayton, N. M., will install a municipal waterworks system to cost about $60,000.

Twelve thousand dollars bonds have been voted for a waterworks system at Troy, Idaho.

Fred C. Clark, of Rockwell City, Iowa, is planning the erection of an ice-manufacturing plant.

The Lake Superior Paper Company will equip a 40,000-horsepower plant at Sault Ste. Marie.

Sidney Blumenthal & Co., Shelton, Conn., will install two 200-horsepower water-tube boilers.

The boiler house of the Franz Hill Brewery, Trenton, N. J., was burned. Loss, $10,000.

The Sacramento Valley Power Company, Chico, Cal., will erect a new power plant on Deer creek.

The Shelburne Falls (Mass.) Electric Light and Power Company will make improvements at its plant.

Alexander Brothers, Philadelphia, Penn., are considering plans for enlargement of its power plant.

The McElwain Shoe Company will build a power house in connection with its new plant at South Manchester, N. H.

The State of Delaware has appropriated $40,000 for a new electric-lighting plant to be erected at Clayton, Del.

The Newburgh (N. Y.) Light, Heat and Power Company will build power stations at Marlborough and Balmville.

The Fairview (S. D.) Milling Company will erect a $50,000 hydroelectric light and power plant at Big Sioux River, Mo.

E. E. Davis, of Northampton, Mass., is interested in a project to erect an electric power plant at Chesterfield, Mass.

The new power house of the Amoskeag Manufacturing Company, Manchester, N. H., was badly damaged by an explosion.

The Waurika (Okla.) Ice and Electric Company has increased its capital stock and will make improvements to its plant.

Work has been commenced on the new city hall, Cleveland, Ohio. An extensive heating and lighting plant will be required.

The Mt. Hood Railway, Light and Power Company, Portland, Ore., will build a new power station at South Milwaukee, Ore.

The Northern Indiana Gas and Electric Company has commenced work on a new $650,000 power plant at East Chicago, Ind.

The American Agricultural Chemical Company, Philadelphia, Penn., is building a new boiler house at Delaware avenue and Bigler street.

Eufaula, Ala., will ask for bids about April 15, for the erection of gas and electric-light plant to cost $50,000. C. S. McDowell, mayor.

The Long Beach (Cal.) Ice and Cold Storage Company has been incorporated with $75,000 capital by L. M. Enos and H. D. Mapes.

The Portland (Ore.) Railway, Light and Power Company will enlarge and make improvements in its power plants to cost $4,000,000.

The Anstell Power Company, Atlanta, Ga., has been incorporated by C. C. Buckner, Geo. W. Mason and Geo. E. Zimmerman to build a power plant.

The Eagle Rock Water Company, Los Angeles, Cal., has been granted a franchise and is planning the installation of an electric-lighting system.

Power-plant equipment will be required for the new 12-story hotel to be erected for E. M. Statler, at Cleveland, Ohio. G. B. Posts & Sons, architects.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids April 18 for gasolene engine as per Schedule No. 3451.

Bids will be received until May 4, by the constructing quartermaster, Fort Mason, Cal., for new pump house and machinery to be erected at Fort Baker, Cal.

The Consumers Electrical Company has commenced work on its new power plant at Forty-second and Water streets, Wheeling, W. Va. Plant is to cost over $700,000.

A new municipal water plant will be built at Aiken, S. C. Two pumps of 750,000 gallons capacity each and two Corliss engines will be installed. Harry Ludlow, superintendent.

The Augusta & Aiken Railway and Light Company, Augusta, Ga., will erect an addition to its power house and install one 2000-kilowatt steam turbine and three new boilers of 425 horsepower each.

The Rogue River Electric Company, Medford, Ore., will purchase two 5000-kilowatt generators for its power plant. The company is also planning to build a new power plant to cost about $100,000.

Power equipment will be required for the 16-story office building and 12-story hotel to be erected at Cleveland, Ohio. Myron T. Herrick is head promoter and D. H. Burnham, of Chicago, is architect. Over $4,000,000 will be expended.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until 11 a.m., April 29, for air compressor and accessories for naval station at Pearl Harbor, Hawaii. Specifications can be had of the bureau.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids up to 11 a.m., April 29, for six 450-horsepower water-tube boilers, equipped with oil-burning apparatus, superheaters, flue and stack for the naval station, at Pearl Harbor, Hawaii.

The San Joaquin Light and Power Company, of Los Angeles and Fresno, Cal., will issue bonds for $25,000,000 for extensive improvements. Capacity of steam plant at Bakersfield will be increased, substations built at several places and pumping plants installed.

# HELP WANTED

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

ENGINEERING SALESMEN wanted for our Chicago and Cincinnati offices. Apply respectively, Schutte & Koerting Company, 805 Security Building, Chicago, and 12th and Thompson Sts., Philadelphia.

STEAM TRAPS AND PACKINGS—Substantial commission offered to a thoroughly competent salesman calling regularly on architects and building contractors to handle best and cheapest steam trap and a complete line of imported steam packing. Apply "Energy," Care POWER.

WANTED—Engineer to take charge of 50 kilowatt producer gas plant for electric lighting; applicant must be familiar with Westinghouse gas engines and producers; state

age, experience and salary desired; climate very good; living expenses about six dollars a week. Address Arsuaga & Co., Ltd., Box 41, Manati, Porto Rico.

POWER EQUIPMENT sales manager wanted by a power plant equipment manufacturing concern; an assistant sales manager, having technical education, practical motive power experience and demonstrated capacity for organization, correspondence and sales getting. Address in confidence, with full particulars, including salary expected. Employers Service Agency, 170 Broadway, New York.

WANTED—A first class machinist and repair man as assistant to head machinist in paper mill; must be familiar with quick repair work on this or similar kind of work and capable of laying out work and handling 30 to 40 men; experienced on boiler and engine repairs essential; this is an excellent opportunity for a first class man; give experience, references and salary expected. Box 419, POWER.

## SITUATIONS WANTED

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

YOUNG MAN, 24 years of age, wishes position as engineer; five years' experience on producer gas engines; A-1 references. Box 421, POWER.

WANTED—A position as stationary engineer, day man, in lighting plant or factory; six years' experience; best of reference. W. J. Hardwick, Schoolcraft, Mich.

ASSISTANT SUPERINTENDENT position; experienced on design and manufacture of gas and steam engines, pumps and general machinery. Box 418, POWER.

WANTED—Position by married man as engineer; Ohio license; four years in light, plant and water works; manufacturing or power plant in Ohio. "F. A. W.," POWER.

## MISCELLANEOUS

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

SEND 50c. for a superior metal polish formula. Geo. R. Williams, 329 E. Hardin St., Findlay, Ohio.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—Herbert Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make a free search and report if patent can be had and exact cost.

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

CITIZENS WATER COMPANY, Burlington, Iowa. Sealed proposals will be received until noon Saturday, April 15, 1911, for a direct connected centrifugal pump and steam turbine, a waterworks surface condenser and air pump; also for a 16-inch Venturi meter with register and chart recorder; information on application. Frank Lawlor, Superintendent.

## FOR SALE

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—American improved steam indicator with Victor reducing wheel, two single cocks, one extra spring, all in mahogany case; one planimeter, all new, never been used, seventy dollars. Address Box 420, POWER.

FOR SALE—One 75-horsepower Weber gas engine, direct connected to generator; one 120-horsepower Jacobson gas engine, belted; one 125-horsepower gas producer; one 160-horsepower gas producer, for anthracite coke; all in good condition and can be seen in operation. Box 417, POWER.

FOR SALE—Complete electric light and power outfit consisting of one 35-horsepower Brownell steam boiler, one 25-horsepower Troy steam engine, direct connected with a 15 kilowatt direct current 7½ ampere storage battery, made by Electric Storage Battery Co., and all necessary equipments, such as switchboard, etc.; outfit is nearly new; will sell at a bargain. Kable Brothers Co., Mount Morris, Ill.

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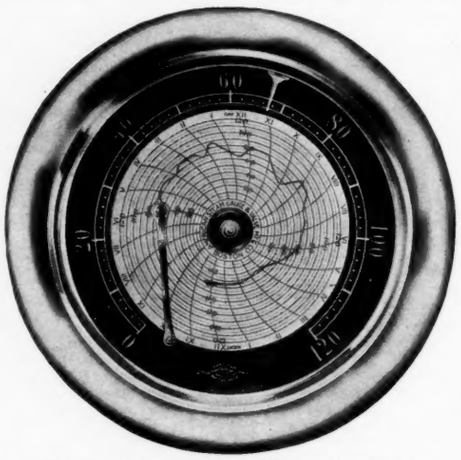

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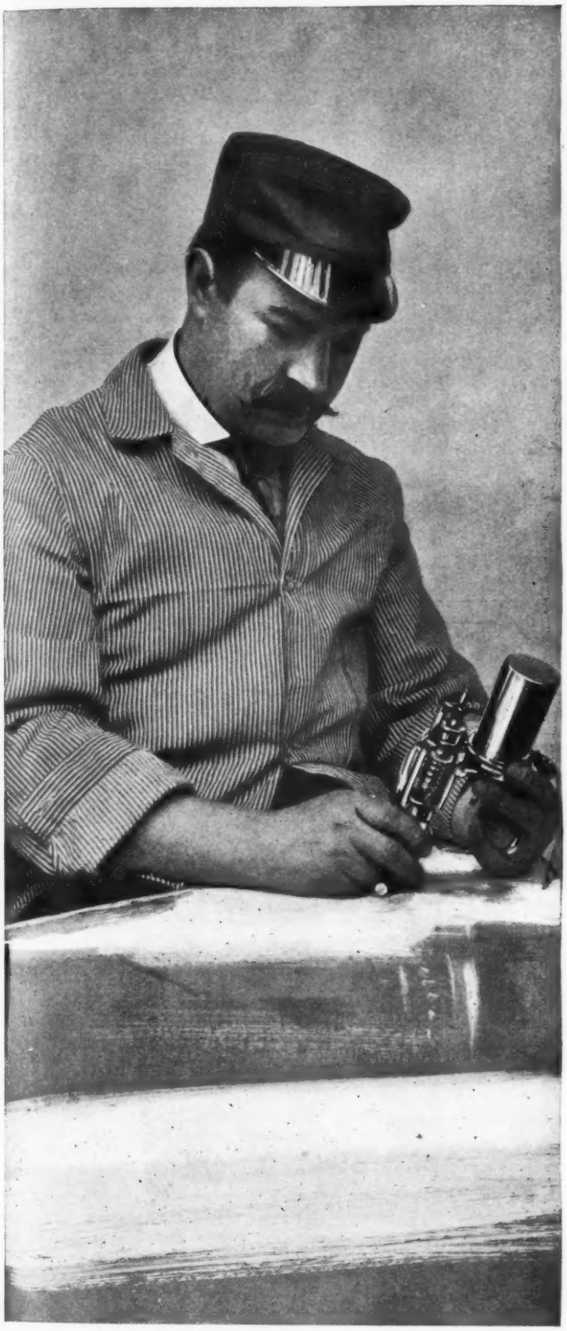

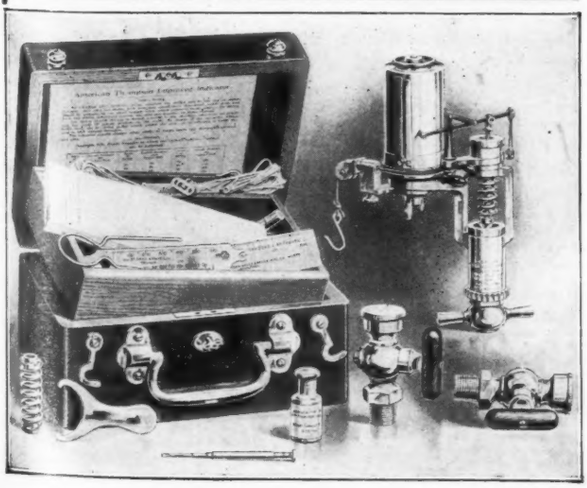

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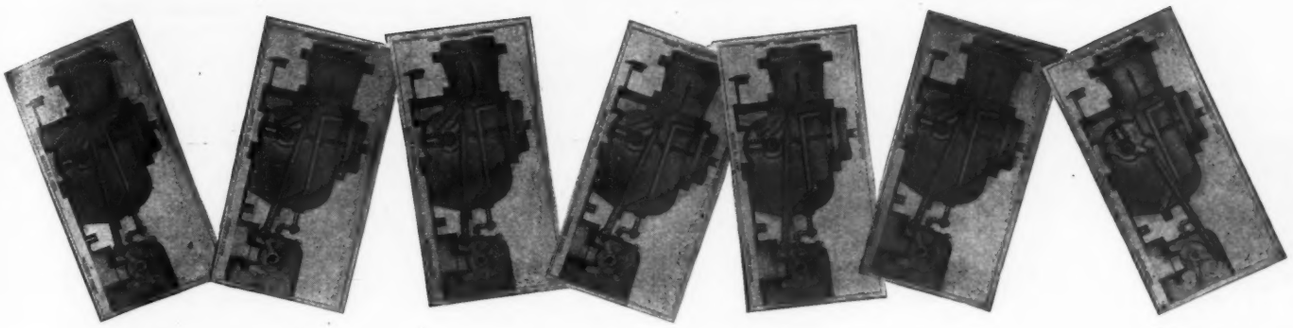
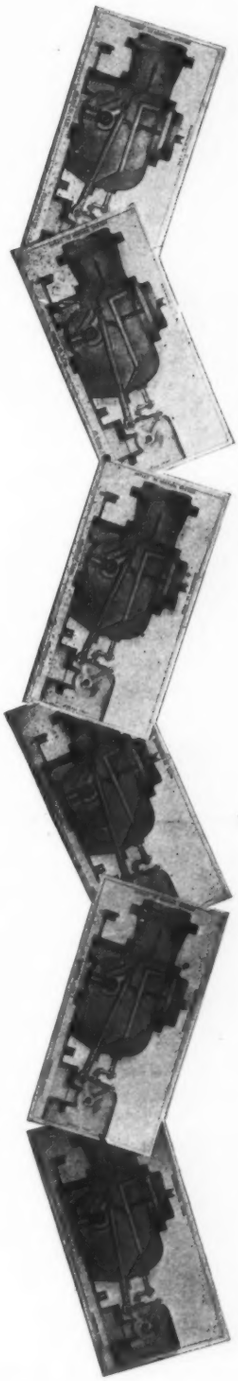


# Send For This Model Valve Motion Illustrating The Convenience, Simplicity And Safety Combined In The Cochrane Steam-Stack And Cut-Out Valve Heater And Receiver.



The **Cochrane Patented Steam-Stack** and **Cut-Out Valve Heater** and **Receiver,** as installed in exhaust steam heating and drying plants of all kinds, performs the functions of and takes the place of the following apparatus:

1. The Oil Separator, to purify of oil the exhaust steam delivered by the engines and pumps, before it passes to the feed water heater or to the heating or drying coils, thereby protecting the latter from accumulations of oil, and making it possible to utilize the condensate for boiler feeding;

2. The Returns Tank or Hot Well for receiving the condensed exhaust steam and any live steam drips or other water about a plant suitable for boiler feed purposes;

3. The Automatic Make-up Water Regulator, for admitting the amount of cold water necessary to supplement the returns and drips;

4. The Feed Water Heater for heating this water up to 210° F. or hotter; according to the back pressure carried, before feeding into the boilers; and

5. The Skimming and Filtering Tank required for purifying the water.

In addition to these functions, the **Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver** provides for the escape of air and gases driven off from the water by heat, thereby reducing its tendency to corrode the boilers and to deposit scale therein.

The above appliances installed as separate pieces of apparatus require numerous pipes, valves and other fittings for their inter-connection, especially if they are so arranged that the feed water heater can be cut out of circuit from the heating system for cleaning or inspection while the oil separator continues to supply exhaust steam to the heating system. Frequently, where such valves are installed, operatives forget or neglect their operation, resulting in stalling the engine, introducing high pressure steam into the heater, or possibly scalding persons engaged in cleaning the heater.

The valve motion used in the **Cochrane Steam-Stack** and **Cut-Out Valve Heater** and **Receiver,** and illustrated by the celluloid model shown, surrounding two sides of this page, absolutely prevents any mistake in the control or operation of the valves. As will be seen from the model, the steam valve cannot be operated without operating the heater overflow valve, and moreover the connecting link is so designed that the small valve opens before and closes after the larger valve, insuring that the latter will not be subject to unbalanced pressure while opening or closing.

*We shall be pleased to send one of these celluloid models, together with a copy of our* ***"Exhaust Steam Heating Encyclopedia,"*** *to any engineer in a plant having exhaust steam not at present utilized and needing heat for buildings or for boiler feed water, who will send*

(1) Information about the H.P. of engines and boilers, whether condensing or non-condensing;

(2) The name of the plant;

(3) His own name and address.

## Harrison Safety Boiler Works

**17th & Clearfield Sts.** **Philadelphia, Pa.**

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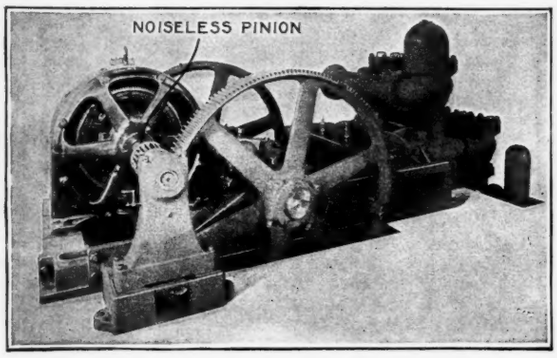


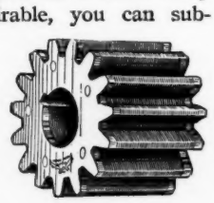

# NEW PROCESS NOISELESS PINIONS

have come to be considered a standard and necessary part by many prominent American builders of motors, machine tools and power plant units. The installation shown is typical. On such machinery, New Process Pinions offer the most economical and certain relief from the annoying clatter of metal to metal gearing, and also provide a cushioning effect that protects the machine from otherwise destructive vibration.

New Process Pinions are silent when old as well as while new, and where used under proper conditions are just as durable as metal. We have customers who appreciated this twenty years ago and are now using more New Process Pinions than ever before.

If your line of machinery is noisy on account of the metal to metal gear drives, let us figure on adding New Process Pinions as a part of the regular equipment, and refer you to similar machinery where New Process Pinions have given perfect satisfaction.

If, on the other hand, you have some noisy drives where quiet is desirable, you can substitute New Process for the metal pinions without inconvenience or big expense, and will be pleased with the results. Ask for booklet, "Noiseless Gearing."



## THE NEW PROCESS RAW HIDE CO.

SYRACUSE N.P.R.H. NEW YORK

6.

*If you want your boilers to be clean at all times*

# Use Favorite Boiler Compound

FAVORITE COMPOUND is sold strictly on its merit. It must put an end to scale in the boilers or there will be no charge. It is a vegetable compound, that will keep the boilers clean at lowest cost.

It has received eight gold medals for efficiency and quality.

Send us a sample of your scale; it will be analyzed in our laboratories by expert chemists, and our Compound guaranteed to meet your special requirements to keep your boilers in perfect working condition.

*Write for particulars.*

**Osgood Manufacturing Co.**
**614 West 79th Street, Chicago, Ill.**

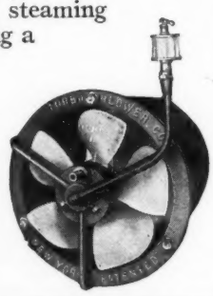
# For Every Type Of Boiler

No matter what kind of boiler you may be using you can increase its steaming capacity 25 to 35% by installing a

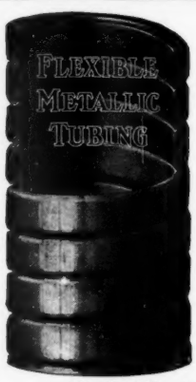
**Turbo-Blower**

Effects complete combustion of any grade of coal. Prevents coal waste.

*Pamphlet?*



**Turbo-Blower Co.**
**30 Church Street, New York City**

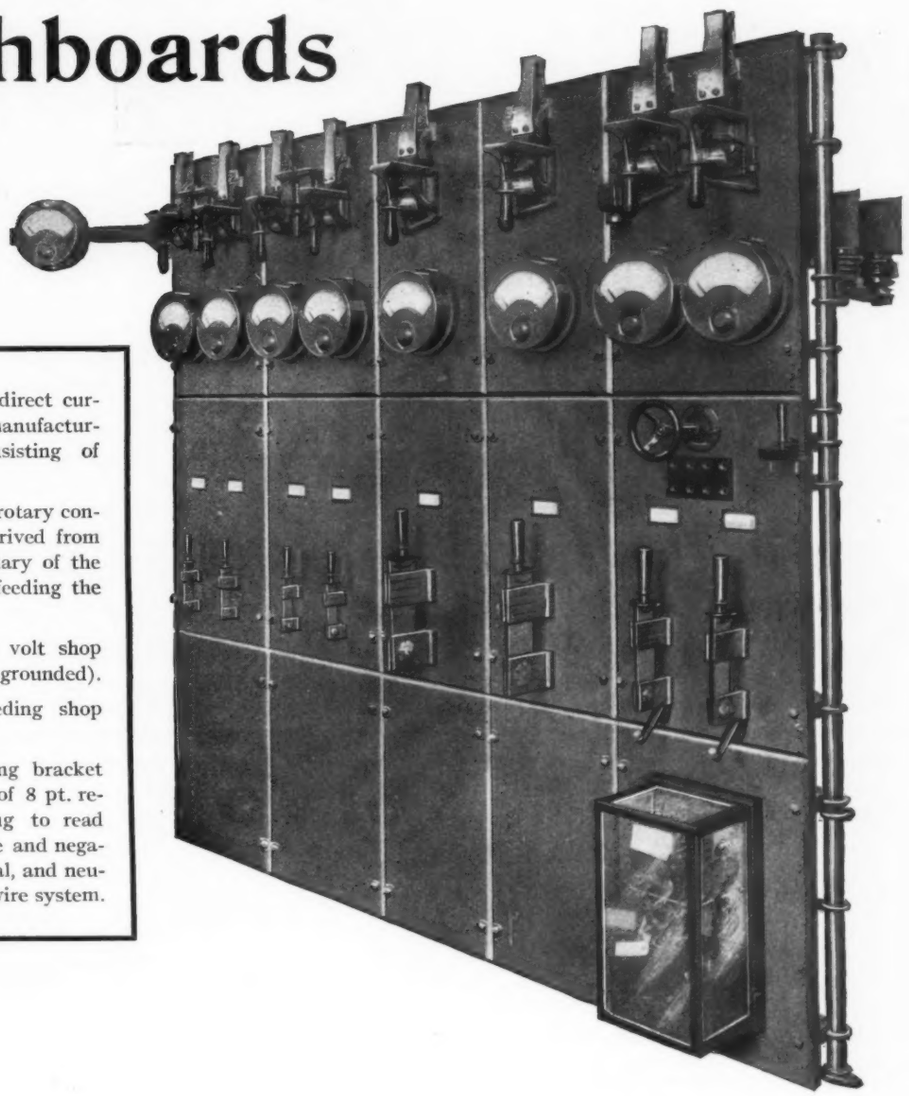


PENNSYLVANIA FLEXIBLE METALLIC HOSE *absolutely* outlasts all other makes. The four-wall construction makes it a perfect hinge. Sizes ¼" to 12". *Write for new Catalog.*

**PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.**
**Manufacturers of Flexible Metallic Tubing**
**1305 Arch St., Philadelphia, Pa.**
(Works) 72nd and Powers Lane, West Philadelphia.
New York Chicago Detroit Boston Cleveland

**U. S. Flexible Metallic Tubing Company,**
San Francisco Los Angeles St. Louis, Mo. Houston, Texas

# Long Service Switchboards



Five panel, 500 volt, direct current switchboard for a manufacturing establishment consisting of (from left to right)

One 3-wire 500 volt rotary converter panel—neutral derived from the Y connected secondary of the step-down transformer feeding the converter.

Two panels for 250 volt shop trolley system (neutral grounded).

Two panels for feeding shop motors.

Voltmeter on swinging bracket—connected by means of 8 pt. receptacle and 4 pt. plug to read voltage between positive and negative, positive and neutral, and neutral and negative of 3-wire system.

A long and satisfactory life is invariably the record of a General Electric Switchboard.

G.E. Switchboards are dependable and give years of excellent service.

All raw materials of the very highest grade.
Every principle of design universally accepted as correct.
Every important step in manufacture carefully tested and inspected.
Every detail accurately worked out in the light of knowledge and experience.

'Phone our nearest office for particulars.

## General Electric Company

**Principal Office: Schenectady, N. Y.**

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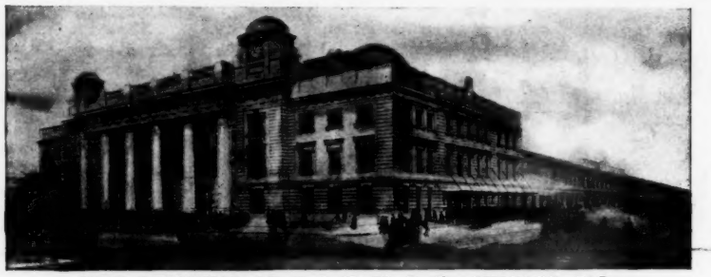
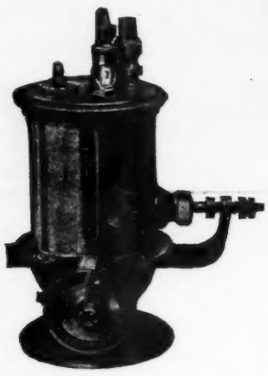


NEW TERMINAL OF C. & N. W. R. R., CHICAGO, ILL.
*Pierce, Richardson & Neiler, Consulting Engineers.*



ONE-FEED PHENIX LUBRICATOR.
(Built in Sizes Up to 12 Feeds.)

# *The Largest Railroads Use Phenix Lubricators*

The modern "up-to-the-minute" power plant of the new C. & N. W. R. R. has the finest apparatus throughout—of course that means Richardson-Phenix Lubrication apparatus on all units.

Phenix Force Feed Cylinder Lubricators have been adopted as standard by many railroads. Here's why: They are extremely simple; easy to attach; all wearing parts operate in oil; a positive amount of oil is delivered no matter how variable the travel of the driving part; they are absolutely reliable at any speed up to 1000 R.P.M.; work satisfactorily on any travel from ¼ to 7"; and have no sight feed glasses under pressure.

Other reasons why the Phenix is best, are described in Bulletin 54. Write for copy today and learn why the P. R. R., the N. Y. C. R. R., the Atchison, Topeka & Santa Fe R. R., and many other prominent railroads have adopted the Phenix for lubrication.

THE RICHARDSON-PHENIX CO.

LARGEST EXCLUSIVE MANUFACTURERS OF OILING DEVICES

Works: Milwaukee, Wis.

Offices in all large cities.

18



# Why Was The Edison Service installed in 97 out of every 100 Buildings put up in New York City last year?

¶ For these 5 good and substantial reasons. Reasons sufficiently strong to compel a careful investigation on the part of every man in New York City, of the possibilities in The Edison Service for solving his problems of lighting and supplying power.

¶ Because The Edison Service reduced the *cost* of supplying light and power to these buildings.

¶ Because The Edison Service made these buildings *safer* places in which to live and work.

¶ Because it also made them more *comfortable.*

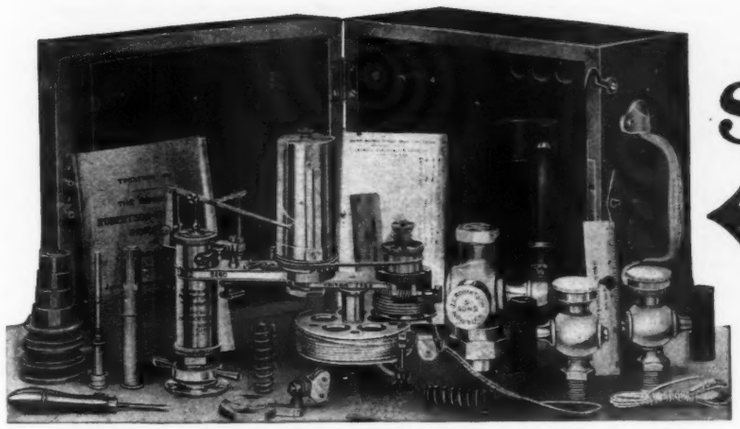
¶ Because it left *more space* to be devoted to productive uses.

¶ Because The Edison Service assured the highest *quality* of light and power.

¶ *A call on the telephone, or a post card, will bring immediate response. And will place you under no obligation, whatever.*

## The New York Edison Co

55 Duane St., New York City



# $5^{00}$ Stands Between You And The Robertson-Thompson Indicator Outfit

You want the best and a most complete outfit when you buy one?

Think well of what an indicator outfit must do—all that it means to you, and you will give careful consideration to your selection—when you do buy.

Now, we are going to say a word or two to you about the ROBERTSON-THOMPSON INDICATOR OUTFIT which takes in the VICTOR REDUCING WHEEL and all accessories for both.

If we took, or you took these instruments, and feature by feature, mechanism, material, finish, everything, and compared them side by side with any indicating outfit made, you would find in this comparative test, that the ROBERTSON-THOMPSON outfit is well entitled to hold first place.

They are made in that exceptional way that enables them to do accurate work and still, all the strength and beauty that can be put into such instruments is there.

You cannot do more than give your employer the best that is in you. Your engine cannot do more than give the best it has to give and we cannot do more than make the ROBERTSON-THOMPSON INDICATING OUTFIT as good as it can be made—the best.

One thing, however, you get when you buy a ROBERTSON-THOMPSON INDICATOR OUTFIT and that is completeness—a full outfit, no extras needed, and the price is only $50.00—$5.00 down and $5.00 monthly.

The full outfit is sent to you by sending your first payment of $5.00 and after you receive the outfit you *can keep and* EXAMINE it for five days; if it is not all you expected, let it come back at our expense and we will return your money.

Further, if at any time after you purchase the instruments, any part of the ROBERTSON-THOMPSON INDICATOR OUTFIT OR VICTOR REDUCING WHEEL becomes deranged through defective workmanship or material we will replace it for you without cost.

Try as you may you cannot improve on this offer.

The ROBERTSON-THOMPSON OUTFIT, Indicator and Reducing Wheel, packed in handsome hardwood case, with lock and key and nickel plated trimmings, and fitted with extra $\frac{1}{4}''$ area piston, detent motion, two springs, as selected, either one three way or two straight way cocks, scales, card, oiler, cord, book of instructions, etc., exactly as shown in cut.

The finest and most complete indicating outfit at one price—first and last. Send in first payment and a few references and the instruments are sent to you.

A Willis Planimeter for $12.50—$2.50 down and $1.25 monthly.

If you are interested in our Indicator proposition, sign coupon and we will send you full particulars of our indicator outfit and easy term offer, together with catalogue and Engineers' Log Book. An easy method of keeping records, fuel and oil used, when engine was started and stopped, loads carried, etc. There is a place for everything you want to keep track of. Just the book you want. It comes FREE—only send in the coupon.

**James L. Robertson & Sons**

**76-78 Murray Street** **New York City**

POWER No. 53. Send me FREE copy of the ROBERTSON Log Book and full details of the ROBERTSON-THOMPSON INDICATOR OUTFIT offer.

Name . . . . . .

Address . . . . . .

Firm's Name . . . . . .

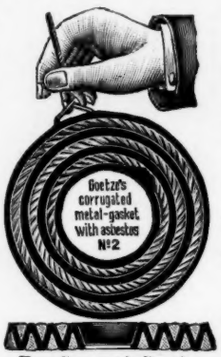
. . . . . .

## Try Goetze's No. 2 Gaskets For Ninety Days At Our Risk

They're for Highest Pressures and Temperatures.

They're for Highly Superheated or Saturated Steam.

They're for Long Lines.




For Severest Service on Flanged Pipe Joints

They're for those "mean" joints that other gaskets have failed to hold.

They can be used over and over.

They make tight joints and *keep* them tight.

**And You'll Use Them As Long As You Live**

If in a hurry, send your order by "Night Letter" at our expense. We'll fill it within 30 minutes after its receipt.

If your order amounts to $10, or over, we'll Prepay Express charges to any part of the United States.

**American Goetze-Gasket & Packing Company,**
**New Brunswick, New Jersey.**

## AT LAST!

### A Cement That Withstands 3000° Fahrenheit

After several years' research and exhaustive tests in experimental work on Refractory Cements, we have at last perfected and are ready to supply the trade with J-M Refractory Cement in several forms to meet all conditions.

These cements will resist temperatures as high as 3000 degrees Fahrenheit, and are especially recommended for use in setting up and lining brass, iron, oil burning, tilting and rotary furnaces, cupolas, assayers' crucibles; also for setting up and facing side walls and bridge walls of boilers, furnaces, etc.

## J-M Refractory Cements

hold a structure intact under the highest temperatures. They will save at least 50% in maintenance costs. Are superior to fire clay and other similar materials, which fuse under heat, run and allow joints to open up, causing leakage and finally so weakening a structure that it is liable to collapse.

Why run such a risk with inferior cements that cause disastrous conditions? Write our nearest branch today, stating class of furnace, temperature, and troubles you experience, and we'll prescribe the remedy.

**H. W. JOHNS-MANVILLE CO.**

Manufacturers of Asbestos and Magnesia Products, ASBESTOS Asbestos Roofings, Packings Electrical Supplies, Etc.

Baltimore, Boston, Chicago, Cleveland, Dallas, Detroit, Kansas City, London, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburg, San Francisco, Seattle, St. Louis

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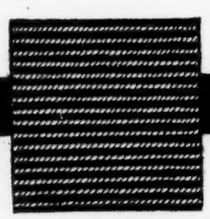
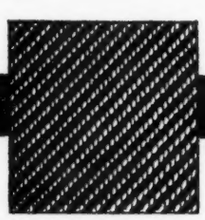
For Canada—THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED, Toronto, Ont., Montreal, Que., Winnipeg, Man., Vancouver, B. C.



Cross Section of Ordinary Packing



Cross Section of Skookum Packing

**There are many packings on the market, but a single trial of**

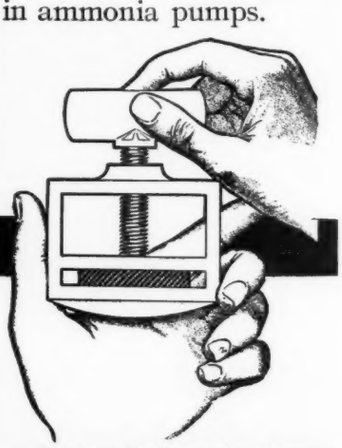
# SKOOKUM

**will prove to any engineer that it is the best, most satisfactory piston rod packing than can be bought to-day.**

**Skookum** gives perfect service because it is made of the finest materials and is the only one piece packing made with diagonal cross expansion.

**Skookum** serves equally well in any kind of engine; with high or low pressure steam, hot or cold water, hot or cold air and in ammonia pumps.

Ordinary Packing under Pressure



Skookum Packing under Pressure

We will cheerfully mail free a test sample to any one interested. Comes in all sizes from 3/16 inch up.

**Bowers Rubber Works,**
**San Francisco, California, U. S. A.**

# *The CO₂mbustion Recorder Saves You Money By Telling You When You Are Losing Money*

It is useless for you to spend money on expensive boiler settings, boilers, stokers, grates, draft systems, etc., and then trust to luck on getting complete combustion.

Highest fuel economy is possible only when you know at all times the degree of combustion in the furnace and the CO₂mbustion Recorder is the simplest and most accurate way of doing so.

Simplicity and accuracy are the superior points of CO₂mbustion Recorders. One glance at the chart tells you all you want to know. The machine does the chemical operations automatically, simply and accurately. An average of less than 2 minutes' attention a day is necessary to keep it in operation.

Cut shows seven machines which were shipped to one concern shortly after a single machine had shown them how to save **12½% in fuel.** This company now has 23 machines.

*Knowledge of what is going on inside the furnace gives the engineer power to cut down fuel expense.*

*Write for complete Catalog.*

## *Precision Instrument Company*

***49 West Larned Street*** ***Detroit, Mich.***

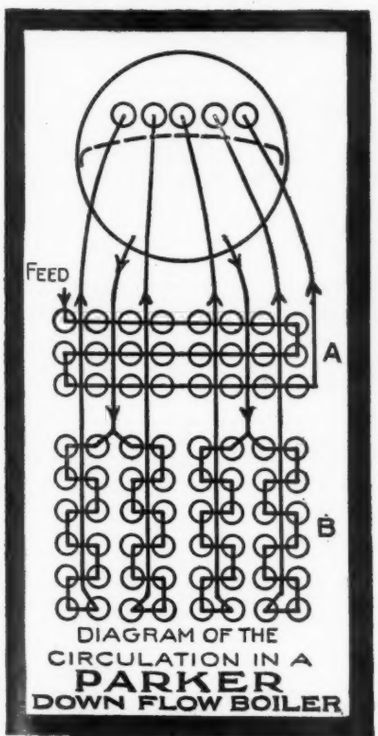
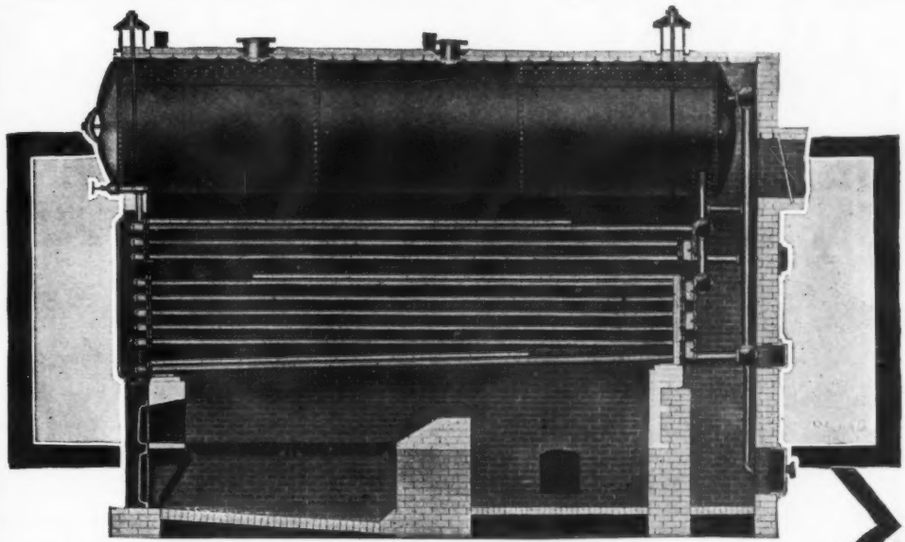



DIAGRAM OF THE CIRCULATION IN A **PARKER DOWN FLOW BOILER**



**"100 To 300 Degrees In The Temperature Of The Gases Saved"**

## The Parker Down Flow Boiler

is a combined boiler and economizer in one setting, which avoids the drop in temperature of the gases occurring between other boilers and separate economizers due to the admission of colder gases through banked or idle boilers and to radiation and air leakage through extra settings and flues. As compared with other boilers without economizers, the **Parker Downflow Boiler** gives about 10% better economy. Look at this diagram on the left. See how the tubes are arranged to form continuous elements and are divided into two sections—the upper tubes forming the economizer, A, and the lower tubes the boiler proper, B. The cold feed water before entering the drum passes through the entire economizer element—where it absorbs heat from the gases after they have left the boiler proper. In other boilers the water in *all* tubes is at the pressure boiling point. The *cooler* water in the upper tubes of the *Parker Boiler* absorbs more of the heat than water at a temperature of 350 degrees. The fact that the escaping gases are 200 degrees lower than in other boilers proves that much more of the heat has been utilized. This is only one of the advantages of the PARKER DOWN FLOW BOILER. There are many more that we want you to know about. Send us this coupon and by return mail we'll forward you catalog and full information. Write now—at least clip the coupon as a reminder.

**PARKER BOILER COMPANY, 1005 Pennsylvania Bldg., PHILADELPHIA, PA.**

COUPON

Parker Boiler Co., 1005 Penna. Bldg., Phila., Pa.
Gentlemen: You may send me your 1910 catalog

Name .....
Position .....
Firm .....
City ..... Number, H. P. and make of boilers .....

P—4-18-11

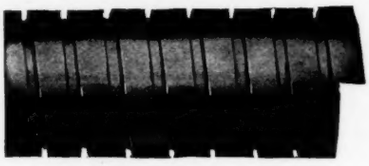
The Relation between Packing and Principle as Demonstrated in

## Black Squadron Packing

Principle is what counts in everything. Black Squadron is a sliding wedge packing built on the universal chuck principle, a combination that gives by far the most satisfactory service for the longest period. Send for sample ring and particulars and you'll understand why. *Send today.*

High Pressure **151 No. Second St.,**
**Cancos Manufacturing Company Philadelphia, Pa.**
*New York*, 145 E. 42 St. *Baltimore*, 37 Franklin Bldg. *Lowell, Mass.*, 196 Cross St.
*Cincinnati, Ohio*, 351 W. Third St. *Boston*, 102 High St.

## American Metal Hose



**For Steam, Oil, Gas or Air**
**Interlocking, double or single groove constructions.**
Write for Price Folder E
**The American Metal Hose Co.**
**Waterbury, Conn.**

## Save Your Stack From Corrosion

Steel smoke-stacks require protection from the corrosion caused by acids, sulphurous and other gases of combustion, rust, etc. If this protection is not provided, they soon pit, rust, corrode and become weakened and worthless.

It pays to avoid all this trouble by lining the stack with

## J-M Vitribestos Stack Lining

This lining, being made of the indestructible mineral, Asbestos (vitrified), successfully withstands the attacks of acids, gases, excessive heat, rust, etc.

It is only one-tenth the weight of fire-brick. This means a less expensive foundation.

It is but 2 inches thick, while most linings are 5 inches thick, so gives greater flue area. On a six-foot diameter stack this increase in flue area, due to the use of J-M Vitribestos, amounts to 15 per cent., and as the efficiency of a stack varies according to its area, an increase here means greater efficiency or a better draft.

It will pay you to look into this matter by writing nearest Branch *today* for our interesting booklet.

**H. W. JOHNS-MANVILLE CO.**

Manufacturers of Asbestos and Magnesia Products. ASBESTOS Asbestos Roofing, Packings, Electrical Supplies, Etc.

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Toronto, Ont. Montreal, Que. Winnipeg, Man. Vancouver, B. C.

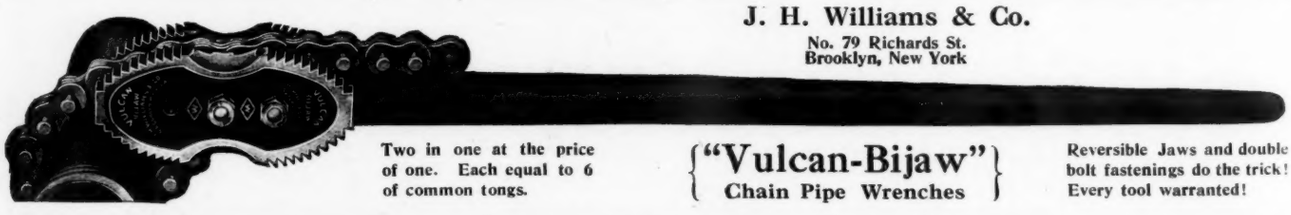
## DUVAL METALLIC PACKING

For superheated steam, high pressure steam and water, excels all other packings, just as

**FOSTER SUPERHEATERS Excel All Other Superheaters.**

**POWER SPECIALTY COMPANY** NEW YORK CHICAGO BOSTON PHILADELPHIA SAN FRANCISCO

**J. H. Williams & Co.**
**No. 79 Richards St.**
**Brooklyn, New York**



Two in one at the price of one. Each equal to 6 of common tongs.

**"Vulcan-Bijaw"**
**Chain Pipe Wrenches**

Reversible Jaws and double bolt fastenings do the trick! Every tool warranted!

INDIAN Red Efficiency counts big in the continuous and economical operation of the power plant.

*"Engineers Know."*

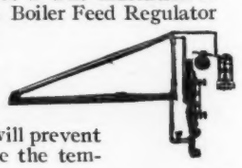
## Indian Red Sheet Packing

**Manufactured by**

**The Diamond Rubber Company**
**Akron, Ohio**

## Can You Always Rely On The Gage Glass?

Even if your fireman or water tender keeps a constant eye on the water glass, it is liable to be dirty or clogged up with sediment, so that very often the height of the water in the gage glass is not a true indication of conditions in the boiler. A Copes Boiler Feed Regulator feels the height of the water in the boiler; it operates on the expansion tube principle. Ask us for our book "P" on boiler feeding, which tells how the Copes Regulator works, and how its use will prevent low water and high water and raise the temperature of water from heaters.



No. 95

**Northern Equipment Co., 408-418 West Indiana St., Chicago, Ill.**